



Established 1990 Located at the University of California, Davis

**Western Center for Agricultural Health and Safety (WCAHS)**

A NIOSH Agricultural Safety and Health Center

**Year End Annual Report**

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## SECTION I

Agriculture in the Western United States represents one of the most intensive and productive operations in the world. Due to the climate, social and diverse crop types, agriculture in the Western U.S. differs in many ways from the rest of the country. The overall goal of the Western Center for Agricultural Health and Safety (WCAHS) at UC Davis is to improve the health and safety of farmers, farm family members, and hired farm workers and their families through research, education and public service programs. WCAHS at UC Davis is uniquely situated to address these issues based on its strategic location in the heart of California's Central Valley and its co-location with UC Davis Schools of Medicine and Veterinary Medicine, the Colleges of Agricultural and Environmental Sciences, and Engineering. The multidisciplinary nature of the Center faculty has facilitated a wide variety of field-oriented research projects, along with diverse training and educational programs, and intervention schemes.

Currently, in partnership with our UC Davis Biological and Agricultural Engineers, development of better ergonomic solutions to reduce acute and cumulative trauma injuries is forefront. Additionally the Center has created bilingual/bicultural health and safety programs and materials for immigrant farm workers in partnership with several government agencies and NGOs (see Outreach Program). Our assessment of potential links between respiratory disease and exposures in Western farming environments provides on-going outputs and impacts (Pinkerton), and a novel research project is evaluating the costs and financial effects of adverse health outcomes on a local and national level (Leigh).

The WCAHS has over twenty years of experience facilitating a collaborative environment among UC Davis Center investigators, community stakeholders, and national and international communities interested in agricultural health and safety. Priority goals include translating research to practice, conducting educational and training workshops, and actively preparing next generations of public health researchers. To this end, WCAHS has funded well over 40 graduate students and many young faculty committed to understanding and improving health and safety in agricultural workplace settings, and occupational health in general.

## Current Work and Relevance

### A. Administrative Core

The Director and Center Manager provide outreach/relationship building, infrastructure and support for the Center's day-to-day functions (NIOSH grant and multiple sub-contracts' management, including meetings of the Administrative Committee, Steering committee, and the Annual Strategic Planning External Advisory Board). The Core management provides leadership input for NIOSH and NORA/AFF collaborative efforts, and guides the Center's three Administrative Core Programs: 1) Outreach; 2) Pilot Grants/Feasibility; and 3) Evaluation. The Center hosts monthly seminars during which guest speakers present free educational and informative discussion forums open to the public. Video-taped presentations and/or PowerPoint presentations are available at: [http://aqcenter.ucdavis.edu/seminar/webcast\\_2013.php](http://aqcenter.ucdavis.edu/seminar/webcast_2013.php)

**Goals and Priorities:** A major goal is building new partnerships to support and leverage WCAHS' mission through private and public partnerships. Our highly successful annual retreat featured CalOSHA Chief Ellen Widess and CDFA Undersecretary Sandra Schubert who rearranged her afternoon schedule to remain for discussions and to answer the many questions that followed her

presentation. Topics included worker health and safety issues involving newly designed and implemented equipment, farmworker tasks, mechanization, labor contractor violations, over-time pay, heat stress, night work. An important panel discussion, titled: "Private-Public Collaborations" was facilitated by Frank Mitloehner, PhD, WCAHS Director of Research. Panel members were Chris Zanolini/CEO, Agriculture Association Management Services, Inc.; Veronica Vargas/Project Coordinator, Reiter Affiliated Companies; and Jay Schreider, PhD, Senior Toxicologist, Cal-EPA. Panelists provided their experiences and insights, from which emerged discussion of short and long term goals. Short term: 1) Strengthen social media outlets, enlist Center Investigators to blog and tweet farmwork health and safety findings/tips and targeted research results, 2) improve utilization of UC Extension Specialists, 3) Attend professional association and producer meetings to identify emerging issues (Enated Year 2). Long term: 1) Communication, Communication - know your audience and become the "go-to" resource. 2) Think big – approach the big guys, the Walmarts, MacDonalads, etc. Worker safety and health is an equal part of their sustainability, in addition to being socially responsible.

The Center efforts are characterized and disseminated by diverse media (webpage, quarterly newsletters, podcasts, and multi social media outlets.) The successes of all Center activities are evaluated within our new comprehensive evaluation program on an on-going basis.

### **Accomplishments:**

- WCAHS Director of Research, Frank Mitloehner, selected to chair the United Nations Food and Agricultural Organization committee on the environmental impacts of the livestock industry.
- WCAHS collaboration in a \$6 million study of egg production in the U.S.
- New WCAHS External Advisory Board member, C. Brian Little, Director, Labor Affairs, California Federated Farm Bureau
- WCAHS Junior Researcher Specialist José Gutierrez, a former child farmworker, was selected as a keynote speaker for 2011 TEDxFruitvale, held at Mills College, Oakland, CA.
- WCAHS Associate Director Kent Pinkerton's collaborative document, "Rising Temperatures, Raising Health Costs" on climate change and human health was featured on *Voice of America*, *UC News and World Report* and *London's Daily Express*.
- WCAHS Specialist Teresa Andrews was invited to give an overview of the Center's Outreach and Education Program at the Conferncia Binacional De Promotores, Oaxac, Mexico.
- WCAHS Associate Director Kent Pinkerton and UC Davis Chancellor Linda Katehi provided input to a broad group of scientists, faculty and administrators regarding a global vision effort at UC Davis in education, outreach and broad inter-disciplinary engagement where social and policy issues encompasses potential partnerships with WCAHS.
- MICASA Project Manager, Maria Stoecklin-Marois, gave an AgriSafe Webinar, "Engaging Hired Farmworkers in Agricultural Health Research" to representatives from 15 U.S. states and 2 Canadian provinces in April 2012.

- WCAHS Associate Director Kent Pinkerton reviewed “Evaluation of mass and surface area concentration of particle emissions and development indices for cookstoves in rural India” for *Environmental Science & Technology* in collaboration with William J. Martin, MD, Associate Director for Disease Prevention and Health Promotion, Eunice Kennedy Shriver National Institute of Child Health and Human Development.

## **B. Outreach Program**

The multidisciplinary expertise of the Center faculty and its Education and Outreach Specialist has enabled varied and largely field-oriented outreach and research projects, such as our MICASA cohort study of 400+ farmworker families in Mendota, CA; PASOS-Saludables (with partner Reiter Affiliated Companies); Worker Occupational Safety & Health Training & Educational Program (WOSHTEP with partner CalDIR); Heat Illness Prevention Trainings (with partner CalOSHA). Culturally sensitive educational materials and model interventions have been developed through each of these projects. Areas of focus include creating bilingual/bicultural health and safety programs for immigrant farm workers, their families and communities, exploring the link between respiratory disease and exposures in Western farming environments, sharing through Training-of-the Trainer (TOT) workshops, and educational presentations, demonstrating better ergonomic solutions to reduce acute and cumulative trauma injuries, specifically lifting, stooping, and squatting.

The Center continues its innovative educational efforts to improve health and safety training to Promotoras, embedded in rural communities of non-English speaking farm workers with the Health Initiative of the Americas (PI Castaneda).

## **C. Pilot/Feasibility (Mini Grant) Program**

Three seed grant applications were fully funded for 2011-2012 and an additional two were funded in-part. The Center worked the UC Davis Health Systems, Clinical and Translational Science Center (CTSC) to leverage seed grant funding. The primary research results of Pilot Grants include the following: 1) “*Smart Textiles Materials for Reduction of Heat Stress,*” a pilot grant in Year 2 with a new graduate student and partner from Boise State, ID, Prof. Uwe Reischel; 2) “*Agriculture Dust Exposure and Smoking Related Disease,*” new research on COPD; and 3) “*Impacts of Current Immigration Patterns and Potential Immigration Reforms on Farmers and Farm Workers, Paying Special Attention to Health and Safety Issues,*” which was presented to federal legislators and currently getting bipartisan support.

## **D. Evaluation Program**

Evaluator Program PI, Julie Rainwater, and team meet regularly with Center’s Research Project investigators to track their project progress, specifically in regards to their project aims and milestones. Additionally, a protocol for sharing success stories/impacts/results has been developed for inclusion in a repository of early and short-term outcomes.

Evaluators participated in all meetings of the WCAHS Steering Committee and created a database of issues discussed, solutions proposed, and timing of resolution. A Web-based survey of WCAHS resource users and pilot awardees is ready for deployment. [Evaluation Program Highlights in Section II](#)

**E. Research Core (Projects 1, 2, 3)** Center's multidisciplinary approach has been designed to translate surveillance and research results into preventative interventions. Below are current research projects.

**Effects of California agricultural particulate matter in a murine intranasal sensitization model of allergic airway inflammation (Pinkerton)** Testing of source-oriented particulate samples generated in an agricultural (rural setting) in our allergic mouse model has been implemented to determine the effects of particle exposure during the sensitization phase of allergic airway inflammation to model asthma. Preliminary studies confirm enhanced inflammatory and cytokine-mediated responses to combustion-generated particles and source oriented PM.

**Using large national datasets and econometrics in agricultural injury research (Leigh)** The goal is to demonstrate valid estimates of the number and types of agriculture-related injuries and illness to improve comprehensive surveillance of the agricultural health and safety system. Using analysis of all persons and all years combined in the NAWS, roughly 52,479 respondents from 1989-2009; 19% female and 81% male; 7 ethnicity categories, 70% report "Mexican" as ethnicity; 8 race categories, 47% report white but 41% report "other"; 14% report using Medicaid and 10% report food stamps; 24% are citizens, 24% have a green card and 43% report being unauthorized.

**Impacts of new caging laws in California on worker health and safety in layer hen facilities (Last)**

The overall goal is to determine the effect on exposure of workers to toxic air pollutants upon housing layer hens in unconventional facilities required to achieve compliance with the new caging laws in California (and elsewhere).

**F. Prevention/Intervention Core (Projects 4, 5, 6)**

**Rapid assays for human & environmental exposure assessment (Hammock).** Immunoassays for detecting quick and cost effective detection of agricultural worker exposure to pesticides have been widely adopted in the US and elsewhere and novel tools are now being tested to permit immediate on site detection of harmful pesticide exposures. Additionally, indoor pesticide exposure is a growing concern, particularly from pyrethroids. Pyrethroid concentrations can be especially high in the homes of immigrant farm worker families who live in close proximity to agricultural fields, and who are often faced with poor housing conditions, causing higher pest infestation and more indoor pesticide use. This study will contribute to the body of knowledge that will provide guidance to educators to inform the public, specifically the MICASA study population, not only about pesticide use, but the impact of living conditions on exposure to pesticides.

**Reducing the risk of heat-related illness in western agricultural workers (Schenker).** The purpose is to understand the response of field workers to ambient heat while working different crops in the California Central Valley to reduce risk factors of heat illness. Internal temperature was recorded using an ingestible temperature monitor. Heart rates were recorded as a measure of work intensity. Ambient temperature was recorded on their person by a data logger, and by two weather stations placed at the edge of the work-area. The degree of hydration of the workers was estimated in two ways. A small blood sample collected via the use of a lancet (3-5 drops) was assayed for blood chemistry allowing osmolality to be calculated. The Center's MICASA, Mendota, CA. cohort study's second follow-up survey included a section on heat illness history and risks, over 400 interviews were collected.

**Effects of orchard ladder rung spacing on agricultural workers (Fathallah).** Model and develop an optimized ladder design to reduce falls in agricultural orchard work. The overall work includes theoretical modeling, laboratory testing and validation, and subsequently testing and validation work in the production agriculture environment.

## Key Personnel

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## **SECTION II**

### **Administrative Core Program Highlights**

#### **Outreach Program Highlights** (PIs Stephen McCurdy/Schenker):

##### **1. Pasos Saludables Project – Partnership with Reiter Affiliated Companies (RAC)**

*Pasos Saludables* is a workplace-based lifestyle outreach and intervention program to decrease obesity and diabetes and improve the health of Latino farmworkers. Participants were recruited directly at RAC fields and participated in a series of workshops focused on prevention and lifestyle changes with the specific educational component to improve dietary and exercise habits, reduce obesity levels and risk of type II diabetes. Ninety-minute sessions concluded with a brief group physical exercise activity.

WCAHS provided technical assistance to RAC staff to refine recruitment and to improve class content and delivery, including improvement of educational materials and participatory training methods used during the classes. WCAHS evaluation team worked closely with the education and outreach specialist to evaluate the effectiveness of this phase of the program

**Outcomes:** A total of 608 people participated: 310 farmworkers at the RAC Watsonville, CA, site and 298 farmworkers at their Oxnard, CA, site. The overall retention rate was 55% (Watsonville 46%, Oxnard 64%): Overall weight loss was -4.85 lbs., overall BMI was reduced by -.75, and overall glucose declined -5.83 mg/dl.

##### **2. California Heat Illness Prevention Campaign – Partnering with Cal/OSHA, UC Berkeley & UC Los Angeles**

As part of our Center's collaboration with the Cal/OSHA Heat Illness Prevention Campaign 2012, our special effort this year was to reach the monolingual Latino, Hmong and Punjabi communities. To address cultural and language barriers, we enlisted the support of community leaders and key institutions within each of the targeted groups and used participatory methods of adult education during our workshops and presentations. Our partnerships included: schools, temples, consulates, nonprofit agencies, grassroots leaders, migrant education agencies, growers, University Extension, and farmworker organizations, among others.

**Outcomes:** Our Center was able educate and train more than 2000 workers, which included employers, community leaders, field supervisors and farm workers. **Ethnicity breakdown:** 47% Latino; 20% Punjabi; 7 % Hmong; 4 % Indigenous; 22% Other. **Populations reached by occupation:** 61% Agriculture; 9% Construction; 9% Landscaping; 12% Other. **Population reached by type of outreach effort:** Eight 6-hour Training-of-Trainer "TOT's"– 165 participants; Eight "workshops", 346 participants; and 12 Health Fairs throughout the state. Total = approximately 1500 direct contacts.

##### **3. PI Castaneda, HIA, Director, Professor, UC Berkeley – Occupational Health and Safety Awareness for Latino Immigrants – sub-contract.**

Create Promotoras Training Manual and Virtual Resource Center.

#### **Evaluation Program Highlights** (PI Julie Rainwater)

##### **1. Developing a Cross-Center Collaboration for Evaluation**

### *Ag Centers Evaluators Meeting*

The UC Davis WCAHS collaborated with colleagues from HICAHS and UMASH to organize a meeting of Ag Center evaluators that coincided with the annual American Evaluation Association meeting in Minneapolis. 24 Ag Center evaluators from 9 centers met on October 24, 2012 at the University of Minnesota to share best practices, methods and tools in evaluation of NIOSH Ag Centers. WCAHS Evaluation Program Associate Director, Dr. Stuart Henderson gave a presentation on the Success Case Method in Evaluation. The team developed a handout containing a brief step-by-step guide to conducting success case studies which was distributed to all meeting attendees.

**Future plans:** The next steps in cross-center collaboration among Ag Center evaluators is a joint meeting to be held in April 2013 in Colorado, hosted by HICAHS which will include both evaluators and outreach coordinators. Ag Center evaluators have also established a listserv. The UC Davis center will host a monthly conference call, and will establish an online repository where evaluation teams from each Ag Center can upload and share evaluation materials, such as data collection instruments, reporting templates, and other methodological tools.

## **2. Describing Center Activity and Impact**

### *Presentation Materials*

In response to a recommendation by the WCAHS Advisory Board, the Evaluation Program worked with Ag Center leadership to develop a 5-minute presentation describing the program's goals and highlighting impacts. The presentation is intended as a tool for Ag Center investigators and partners when delivering presentations to community and other stakeholder groups. The Evaluation team produced two versions of the presentation 1) an image-focused presentation appropriate for communicating with low literacy audiences, or audiences with a primary language other than English, and a verbal-focused presentation for audiences with a higher education level or more familiarity with relevant topics in agricultural health and safety.

### *WCAHS Annual Retreat*

The Evaluation team participated in the WCAHS Annual Retreat. Associate Director of Evaluation, Stuart Henderson led a discussion for the Outreach break-out session on the different levels and methods of engagement with stakeholders and the community.

### *WCAHS Seminar*

On May 14, 2012, WCAHS Evaluation Director Julie Rainwater gave a seminar titled "Program Theory-Driven Evaluation", describing the role of evaluation in the Ag Center and how to develop an effective evaluation through stakeholder engagement, logic models and stories of impact.

**Future plans:** The Evaluation team will be working individually with WCAHS investigators and staff to develop program-specific logic models. The purpose of the process is threefold: 1) to provide an opportunity for each program to articulate and visualize the logic that underlies their program activities, outputs and outcomes, 2) to facilitate the identification of measurable outcomes and accessible data sources for measuring outcomes, and 3) to ensure that outcomes and impacts are aligned with NIOSH Agricultural Safety and Health Centers program objectives and relevant NORA Strategic Goals.

## **3. Evaluation of WCAHS Outreach and Translation**

### *Methods for Evaluating Outreach*

Evaluation Program Director Julie Rainwater and Evaluation Analyst Melissa Rose are collaborating with WCAHS outreach program leader Teresa Andrews to identify appropriate and feasible evaluation

methods for assessing the impact of the Center's outreach and education activities (see Outreach Program section of this report for a description of activities).

**Future plans:** Both the evaluation team and outreach leaders from WCAHS will attend the April meeting in Colorado to further develop tools for assessing outreach impact. Data will be collected in the second half of 2013.

### **Research Core Project Highlights**

#### **Project 1: PI Kent Pinkerton, PhD “*Effects of California Agricultural Particulate Matter in a Murine Intranasal Sensitization Model of Allergic Airway Inflammation*”**

**CHALLENGE:** Protocol development and testing of filter extraction methods for removing particulate matter. Extraction in triplicate of particulate matter (PM) samples collected during the winter and summer months at an agricultural site in Davis and an urban site in Sacramento. Development of an allergic mouse model using ovalbumin and house dust mite allergen to test agriculturally-based PM and combustion particles.

**IMPACT #1:** Perfected extraction methods to examine health impacts from particles collected during summer and winter seasons in an agricultural/rural setting. Performed work testing source-oriented samples in an allergic mouse model. Testing of source-oriented particulate samples generated in an agricultural (rural setting) in an allergic mouse model has been implemented to determine the effects of particle exposure during the sensitization phase of allergic airway inflammation to model asthma.

**IMPACT #2:** Further protocol development and implementation of sample preparation techniques for the chemical analysis of extracted PM samples, including ICP-MS, XRF, IC, GC-MS and EC/OC. All chemical analyses will be performed on the extracted PM samples, rather than the filter and substrate samples as is typically the case. Thus, each analytical technique requires its own unique and novel sample extraction and preparation procedures. In addition, methods of resuspension of collected particles as an aerosol have been designed. This is critical to better understand particle-induced biological responses in the respiratory tract.

**IMPACT #3:** The refinement of an allergic mouse model using either ovalbumin or house dust mite allergen to test agriculturally-based PM as well as combustion-generated particles. Studies in this model have demonstrated enhanced inflammatory and cytokine-mediated responses to combustion-generated particles and source-oriented PM.

#### **Project 2: PI: J. Paul Leigh, PhD “*Using Large National datasets (NAWS) and Econometrics in Agricultural Injury Research*”**

**CHALLENGE:** Test hypotheses, assess predictors estimate disparities and current trends. Demonstrate valid estimates of the number and types of agriculture-related injuries and illnesses leading to improved comprehensive surveillance of the agricultural health and safety systems.

The total costs of occupational injury and illness are estimated to be four or five times as large as the amount of benefits paid by workers' compensation insurance carriers for all industries combined. For agriculture, they are likely to be larger than four or five times. Few studies address which groups in the economy pay for occupational injury and illness across all industries combined when workers'

compensation does not. We attempted to answer the question “who pays?” when workers compensation funds fall short for all industries combined. We drew data on numbers of cases and costs per case from the Bureau of Labor Statistics and National Council on Compensation Insurance data sets. Using a mathematical model incorporating parameters from the literature and government reports, we estimated costs not covered by workers' compensation for private and public entities. In 2007, we estimated total benefits to be \$51.7 billion, with \$29.8 billion for medical benefits and \$21.9 billion for indemnity benefits. For medical costs not covered by workers' compensation, we estimated: other (non-workers' compensation) insurance carriers covered \$14.22 billion; Medicare covered \$7.16 billion; Medicaid covered \$5.47 billion; and workers and their families picked up the remainder, approximately \$2.95 billion.

For agriculture, the total amount of cost shifting is likely to be even greater given that workers compensation coverage is narrower. The amounts in the various categories are also likely to differ from all industries combined. Among farm workers, employer provided medical insurance is less than for the population at large, and for undocumented workers, coverage extended by Medicare and Medicaid is severely restricted. It is, therefore, likely that much more of the cost shifting will fall on workers and families than on other insurance carriers or Medicare or Medicaid.

### **Low wages and hypertension.**

**CHALLENGE:** Farm workers earnings are among the lowest in the economy. We undertook an investigation to determine whether low wages were risk factors for hypertension for all wage earners, including farm workers. <http://blogs.cdc.gov/niosh-science-blog/>

**RESULTS:** We found negative and strongly statistically significant correlations between wages and hypertension both in logistic and Cox regressions. The correlations were especially strong for subsamples containing the younger age group (25-44 years) and women. We found that correlations were also stronger when three health variables----obesity, subjective measures of health and number of co-morbidities----- were excluded from regressions. We reasoned that these three (obesity, subjective measures of health and number of co-morbidities) were in the causal pathway running from low wages to hypertension. We estimated that doubling the wage was associated with 25-30% lower chances of hypertension for persons aged 25-44 years. We concluded that the preponderance of the evidence suggested that low wages were risk factors for hypertension.

### **Project 3: PI Jerold Last, PhD “Impacts on New Caging Laws in California on Worker Health & Safety in Layer Hen Facilities”**

**CHALLENGE:** Determine the effect on exposure of workers to toxic air pollutants upon housing layer hens in unconventional facilities required to achieve compliance with the new caging laws in California (and elsewhere).

The testing facility contained multiple separate barns stocked with either battery cages or enriched cages, or operated as free-range enclosures. Total PM emissions varied by caging source, and preliminary results lead to the tentative conclusion that workers' lung responses to toxic particles in a layer hen facility would be directly proportional to measured concentrations of the PM in the indoor air.

**IMPACT:** Our preliminary results suggest that conventional air quality monitoring for the concentration of particulate pollutants (PM) in the indoor air of a layer hen facility is a reasonable surrogate for toxicological evaluation of worker health exposure by animal testing to estimate the risk of lung injury incurred by workers exposed to these particles while collecting birds and eggs and/or maintaining the facility. Mechanistic studies currently being performed on collected PM will further help to define the

nature and extent of the risk to which workers in these emerging new facilities are being exposed. As different Proposition 2-compliant animal housing designs continue to be developed, these studies will lay down a road map for systematic evaluation of the worker health impacts in new layer hen facilities.

### **Prevention /Intervention Core Highlights**

#### **Project 4: PI Bruce D. Hammock, PhD “Rapid Assays for Human and Environmental Exposure Assessment”**

**CHALLENGE:** To develop, validate and use new immunoassays in target populations; improve speed and to quantify exposure on day of pesticide use, determine effectiveness and provide improved pesticide-user information cost-effectively.

**IMPACT:** Immunoassays have been used in medicine for more than 50 years to help physicians determine the state of a person’s health. This study: 1) Provides companies an improvement to immunoassays that could increase the shelf life of products, reducing production costs and allowing the immunoassays to be made available in developing countries where refrigeration is not optimal. 2) Offers researchers an improved method to make antibodies for chemical targets.

**CHALLENGE:** To assess pyrethroid exposure households in homes of immigrant farm worker families who live in close proximity to agricultural fields, and who are often faced with poor housing conditions, causing greater pest infestation and more indoor pesticide use. Participants were recruited from the MICASA study (Schenker), where indoor pesticide exposure was a concern, particularly from pyrethroids, a commonly used class of insecticide. Pyrethroid exposure was assessed based on measurement of the metabolite found in urine, 3-phenoxybenzoic acid (3-PBA) among 105 women and 103 children. Questionnaire data was also collected on pesticide use, housing conditions, and foods eaten on the sample collection day. Indoor pesticide use was common among the population with 59% reporting having insects in their home and 43% reporting a household member applying pesticides in the home. A positive association was evident between poor housing conditions and the urinary 3-PBA level. These data show farm worker families are being exposed to pyrethroid pesticides and that poor housing conditions are a contributing factor, although further research is warranted to fully investigate sources of exposure.

**IMPACT:** This study will contribute to the body of knowledge that will: 1) Provide guidance to educators to inform the public, specifically the MICASA study population, not only about pesticide use, but the impact of living conditions on exposure to pesticides. 2) Assist participants in the MICASA study as well as other consumers to understand pesticide use practices in the home and ways to minimize exposure. 3) Inform regulators to develop or modify pesticide use both in occupational and residential setting.

**CHALLENGE:** The pyrethroid insecticides are rapidly broken down in the body to 3-PBA that is then excreted in the urine. Because excretion happens quickly exposure can occur, but within a few days, no 3-PBA will be seen in the urine. It has been reported that 3-PBA can form protein-adducts. These adducts circulate in the body for as long as months. Measuring 3-PBA protein-adducts may be a way to assess exposure that occurred a few months in the past. Our trained a collaborator used the 3-PBA immunoassay and modified it to measure 3-PBA protein-adducts. She used the assay to measure the

adducts in the blood of farmers and consumers in an agricultural region in Thailand. Her preliminary results show that 3-PBA protein-adducts were detected more often in farmers than in consumers. A larger study is currently underway.

**IMPACT:** This study will contribute to the body of knowledge that will: 1) Inform both U.S. and Thai regulators to develop or modify pesticide use both in occupational and residential settings. 2) Provide guidance to educators to inform the public about pesticide use.

**Project 5: PI Marc B. Schenker, MD, MPH “Reducing the Risk of Heat-related Illness in Western Agricultural Workers”**

As a result of preventable deaths, California’s heat illness prevention requirements were changed in 2010 to include agriculture so that temperatures reaching 95 degrees trigger specific measures, such as closer supervision of employees for heat-illness symptoms and reminding workers to drink water throughout their shift.

**CHALLENGE:** To develop an understanding of the response of field workers to ambient heat while working different crops in the California Central Valley. This knowledge will be applied to reduce the magnitude of the risk factors for heat illness. A physiological field study was conducted in the summer of 2012 and data was collected on work tasks, hydration and exposure to ambient heat and work, inducing internal heat, in 90-100 field workers.

A field study was conducted between late June and mid August 2012, on a variety of farms (7 total) in the California Central Valley ranging from Burrell, south of Fresno, to Woodland, north of Sacramento. One hundred field workers including 13 females were assessed for one day only. Internal temperature was recorded using an ingestible temperature monitor. Their heart rates were recorded as a measure of work intensity. Ambient temperature was recorded on their person by a data logger and by two weather stations placed at the edge of the work- area. The degree of hydration of the workers was estimated in two ways. First a small blood sample collected via the use of a lancet (3-5 drops) was assayed for blood chemistry allowing osmolality to be calculated. Second, before and after their shifts, the workers were weighed, and their clothing noted; change in body weight is a less sensitive estimation of hydration, but was assessed for its utility. Questionnaires were used to record experiences of working in the heat both historically and on the day of participation.

**IMPACT:** The field worker population of California is estimated at over 450,000 with the large majority of Latino ethnicity. California agriculture workers are at high-risk of heat related illness (HRI). Between 2005-09 Cal OSHA received reports of 93 cases of severe HRI in farm workers, including many deaths. Additionally, the rate of heat-related fatalities has increased over the past 15 years. Factors related to high morbidity and mortality rates in farm workers due to heat exposure are varied, but in the population of Latino immigrants the basic need for economic survival experienced by low wage farm workers is thought to make them particularly vulnerable. However, data from the worker's perspective is limited. Using data collected from our specific aims we will describe more comprehensively the HRI risk factors that agricultural workers encounter and devise interventions amenable to the Latino workforce. Subsequently by actual testing and evaluation of these interventions in the agricultural community we expect workable and successful practices to be adopted by the employers and employees.

In summary over 80% of the workers studied (n=100) increased their serum osmolality, with 21% increasing  $\geq 3\%$ . Twenty-two percent lost over 1.5 % of their original body weight (ACGIH suggested criteria for increased risk of dehydration). Associations will be assessed between heart rate, task, crop, ambient condition and core body temperature.

**Project 6: PI Fadi Fathallah, PhD “*Effects of Ladder Rung Spacing on Agricultural Workers*”**

**CHALLENGE:** To model and develop an optimized ladder design to reduce falls in agricultural orchard work. The overall work includes theoretical modeling, laboratory testing and validation, and subsequently testing and validation work in the production agriculture environment. Year 1 included: Reviewing current biomechanical literature and recent anthropometric literature, purchase of musculoskeletal modeling system AnyBody to aid in the development of the biomechanical model; purchased GPM anthropometer for collect of anthropometric data from laboratory and field participants and developing relationships with the ladder and orchard industries.

**IMPACT:** Two orchard ladder companies continue to support the project efforts. One company is a board member of the American Ladder Institute. Another company has started producing their own alternative rung spacing ladder for special purpose use, based on previous work on which this current study is based. Both companies continue to be willing to supply custom ladders for the research project. *Our work to date is submitted for presentation at the 2013 Annual International Meeting of the American Society of Agricultural and Biological Engineers with a paper titled “A Preliminary Evaluation of the Effects of Orchard Ladder Rung Spacing on Workers' Health and Safety.”*

## Outputs

### **Publications (from Project)**

Madl AK, Teague SV, Qu Y, Masiel D, Evans JE, Guo T, Pinkerton KE. 2012 Aerosolization System for Experimental Inhalation Studies of Carbon-Based Nanomaterials, *Aerosol Science and Technology*, 46:94-107.

Plummer LE, Ham WH, Kleeman MJ, Wexler AE, Pinkerton KE. 2012 Influence of Season and Location on Pulmonary Response to California's San Joaquin Valley Airborne Particulate Matter, *Journal of Environmental Toxicology and Health*, 75:253–271.

Plummer LE, Smiley-Jewell S, Pinkerton KE. 2012 Impact of air pollution on lung inflammation and the role of Toll-like receptors. *International Journal of Interferon, Cytokine and Mediator Research* 2012:4 43–57.

Claude JA, Grimm A, Savage HP, Pinkerton KEA. 2012 Perinatal Exposure to Environmental Tobacco Smoke (ETS) Enhances Susceptibility to Viral and Secondary Bacterial Infections *Int. J. Environ. Res. Public Health* 9:3954-3964.

Leigh JP, Marcin JP. 2012 Workers' compensation benefits and shifting costs for occupational injury and illness. *J Occup Environ Med.* Apr; 54(4):445-50.

Leigh JP, Du J. 2012 Are low wages risk factors for hypertension? *Eur J Public Health.* 22(6):854-9.

Kim, H.J., M. McCoy, Z. Majkova, J. Dechant, S.J. Gee, S. Tabares-da Rosa, G.G. Gonzalez-Sapienza and B.D. Hammock. 2012. Isolation of alpaca anti-hapten heavy chain single domain antibodies for development of sensitive immunoassay. *Anal Chem.* 84(2):1165-71. PMID: PMC3264785.

Thiphom, S., T. Prapamontol, S. Chantara, A. Mangklabruks, C. Suphavitai, K.C. Ahn, S.J. Gee and B.D. Hammock. 2012. An enzyme-linked immunosorbent assay for detecting 3-phenoxybenzoic acid in plasma and its application to farmers and consumers. *Anal. Meth.* 4:3772-3778 (2012).

Bethel, JW, Walsh, J, Schenker, MB. Preterm, low-birth-weight deliveries, and farmwork among Latinas in California. *J Occup Environ Med.* 2011 Dec; 53(12):1466-1471.

Hennessy-Burt, TE, Stoecklin-Marios, MT, Meneses-Gonzalez F., Schenker, MB. A Pilot Binational Study of Health Behaviors and Immigration. *Journal of Immigrant and Minority Health: Volume 13, Issue 6 (2011), Pages 1142-1149.*

Garcia J, Bennett DH, Tancredi D, Schenker MB, Mitchell D, Reynolds SJ, Mitloehner FM, Occupational exposure to particulate matter and endotoxin for California dairy workers, *International Journal of Hygiene and Environmental Health*, Available online 12 May 2012, ISSN 1438-4639, 10.1016 / j.ijheh. 2012.04.001.

Armitage T, Mitchell D, Schenker M. Mortality in the California Farmer Health Study Cohort". *Journal of Agromedicine*, 17:288-299, 2012

## **Conference Presentations (from Project)**

CM Carosino, LE Plummer, KJ Bein, AS Wexler, KE Pinkerton. Selection of an Acute Model of Allergic Airway Inflammation for Differential Testing of Source-Oriented Particles. Society of Toxicology, San Francisco, CA March 2012.

LE Plummer, CM Carosino, KJ Bein, Y Zhao, AS Wexler, KE Pinkerton. Toxicity of day/night urban San Joaquin Valley particulate matter is size and season dependent. Society of Toxicology, San Francisco, CA March 2012.

Abstract submitted to the International Conference of Epidemiology in Occupational Health (EPICOH) 2013. Schenker MB, Mitchell DC, Wadsworth G and Jones JH. 'California Heat Illness Prevention Study (CHIPS) in immigrant Latino farm workers.'

2013 Annual International Meeting of the American Society of Agricultural and Biological Engineers with a paper titled "A Preliminary Evaluation of the Effects of Orchard Ladder Rung Spacing on Workers' Health and Safety."

## **Marc B. Schenker - Invited Lectures**

"Adverse Pregnancy Outcomes among Immigrant Latinas in California", XI Binational Policy Forum on Migration and Global Health, San Antonio, Texas, October 3, 2011

"Immigrant workers--where the hazardous jobs are.", UC Irvine, Irvine, California, November 8, 2011

"Respiratory Disease Among Agricultural Workers" NAPCON 13th Joint Conference of Indian Chest Society and National College of Chest Physicians (India), New Delhi, India, November 29, 2011

"Migration and Health: Current Perspectives", India Institute of Public Health, New Delhi, India, November 30, 2011

"The Unequal Occupational Health Burden of Migrant Workers," Internal Medicine Grand Rounds, University of California at Davis, Sacramento, California, December 9, 2011

Plenary Speaker, "Migration and Health", University of California, Berkeley Global Health Day, Berkeley, California, February 4, 2012

"A Social Determinants Approach to Latino Immigrant Health in the United States" Siglo XXI, New York, NY, February 24, 2012

Plenary Address, "Where the Hazardous Jobs Are: Migrant Workers in the 21<sup>st</sup> Century", 30<sup>th</sup> International Congress on Occupational Health, Cancun, Mexico, March 20, 2012

"Adverse Health among Migrants, A Global Health Disparity", Guest Lecturer, Western Australian Institute for Medical Research, Perth, Australia, April 4, 2012

"The Unequal Occupational Health Burden of Migrant Workers, Western Australian Institute for Medical Research, Perth, Australia, April 5, 2012

“Reproductive Hazards of Semiconductors Workers’ and Farm Workers”, Institute for Child Health Research, Guest Lecturer, Institute for Child’s Health Research, Perth, Australia, April 13, 2012

“The Unequal Health Burden of Immigrant Workers”, Guest Lecturer, Monash University, Melbourne, Australia, April 23, 2012

“30 Years of Occupational and Environmental Medicine”, Guest Lecturer, University of California, Davis’ 30<sup>th</sup> Annual Occupational and Environmental Health Symposium, Sacramento, California, May 12, 2012

“Heat Stress”, Guest Lecturer, National Institute for Occupational Safety and Health’s Bruceston Research Center, Pittsburgh, Pennsylvania, May 16, 2012

“The Vision of the University of California in Migration and Global Health Issues”, Guest Lecturer, 7<sup>th</sup> Summer Institute on Migration and Global Health, Los Angeles, California, June 24, 2012

“Regional Challenges of Universities of the Pacific Rim (Health of Migrant Populations and Climate Change and Health), Panel, Association of Pacific Rim Universities (APRU) Global Health Workshop, Los Angeles, California, June 25, 2012