Final Progress Report
Project 1 R21 OH009830-01

PI: Linda A. McCauley
Emory University
Nell Hodgson Woodruff School of Nursing
1520 Clifton Rd NE
Atlanta, GA 30322
linda.mccauley@emory.edu
404-727-7975

Institution: Emory University
Project Title: Pregnancy Health Among Florida Farmworkers
Dates: 10/01/09-09/30/13

Co-Investigators:
Maureen Kelley, Clinical Associate Professor, Emory University
Joan Flocks, University of Florida
Eugenia Economos, Farmworker Association of Florida
Antonio Tovar, Farmworker Association of Florida

Date: March 30, 2014

Table of Contents

List of Terms and Abbreviations

CAC	Community Advisory Committee
CBPR	Community-based Participatory Research
DAP	Dialkylphosphate
DEP	Diethylphosphate
DETP	Diethylthiophosphate
DMDTP	Dimethyldithiophosphate
DMP	Dimethylphosphate
DMPT	Dimethylthiophosphate
ETU	Ethylenethiourea
FWAF	Farmworker Association of Florida
GC	Gas chromatography
GM	Geometric mean
HRI	Heat related illness
NIOSH	National Institute for Occupational Safety and Health
OP	Organophosphate
PFPD	Pulsed flame photometric detection

Abstract

Pregnancy Health Among Florida Farmworkers

Linda A. McCauley, Emory University, Nell Hodgson Woodruff School of Nursing, 1520 Clifton Rd NE, Atlanta, GA 30322, linda.mccauley@emory.edu, 404-727-7975

Agriculture consistently ranks as one of the three most hazardous occupations in the United States, yet few studies have been conducted that examine the specific risks to pregnant women in the workforce. Exposure to agricultural chemicals is a major occupational and reproductive hazard and other factors such as long periods of standing, exposure to heat and dehydration also have the potential to impact the health of pregnant women and their unborn children. In this exploratory study investigators from Emory University, and the University of Florida partnered with the Farmworker Association of Florida and the Farmworker Health and Safety Institute to examine how female farmworkers in nursery and fernery operations assess the risks of certain environmental and occupational hazards to pregnancy. Focus groups with farmworker women revealed a common belief that they are exposed to pesticides at work and that pesticides can affect women of childbearing age and their partners, including infertility, miscarriages, and birth defects. Workers were less aware of the hazards of heat exposure, and had varying perceptions about the impact of heat on a developing fetus. Workers described the work conditions that exist that prevent them from taking action, such as lack of personal protective equipment, insufficient rest/ water and bathroom breaks, and lack of training of both workers and supervisors. Interviews with health providers revealed a reluctance to talk about work exposures with their patients and often not recording occupational information on the health record. Health provider knowledge of occupational exposures was limited. A survey of 260 farmworker women showed that most worked during their most recent pregnancy, with 40-50% working the entire time. Heat related symptoms and access to clean drinking water and bathrooms differed in the two work settings studied. Pesticide urinary biomarkers differed across settings. Although nursery workers had the least concern about pesticide exposure, their biomarker levels revealed higher exposures.

Ninety-seven percent of women in our study reported receiving prenatal care, most seeking care in the first trimester. Pregnancy outcomes were similar between fernery and nursery workers, but fernery workers were much more likely to report that their children had been diagnosed with respiratory disease.

Community workers were successfully trained on the delivery of the reproductive occupational health curriculum using popular education techniques, a web-based interactive visual presentation, and video vignettes featuring local community members. Our results showed a good level of content assimilation, but suggestions were given on how to improve the delivery of the training. Training materials for health providers are also needed.

The results of this study are being disseminated among scientific, health professional, and community groups. Future studies will focus on a closer examination of the association between work characteristics and physiological response to heat and examining the relationship between environmental exposure, inflammation, oxidative stress, and pregnancy health among female farmworkers. Both of these future studies will use a CBPR format and will also expand the work to other agricultural communities in which the FWAF has a strong community presence.

Section 1

Significant (Key) Findings:

Specific Aim 1: Examine current perceptions of work hazards and pregnancy health among female farmworkers working in nursery and fernery operations in Florida.

Focus groups held with 35 farmworker women in two agricultural communities revealed a common belief that they are exposed to pesticides at work and that pesticides can affect women of childbearing age. The study participants were generally aware of acute symptoms of pesticide exposure, but also mentioned infertility in bothmen and women and miscarriages, birth defects and developmental disabilities as possibly related to workplace exposures. There was a belief that chemicals can contaminate a man's blood, leading to genetic transmission to the fetus. Workers also knew the symptoms related to heat exposure, such as headaches, dizziness/fainting, respiratory problems, vomiting, and exacerbated high or low blood pressure. They believed pregnant women working in extreme heat are more prone to dizziness and fainting but expressed varying perceptions about the impact of heat on a developing fetus. Some women said a fetus could "drown from heat" and others pointed out that if a woman becomes dehydrated from not drinking enough water in extreme heat, the fetus will also suffer dehydration. For both pesticide and heat exposures, workers described the work conditions that prevent them from taking action, such as use of protective measures; rest, water and bathroom breaks; and lack of training of both workers and supervisors.

Our interviews with health providers revealed a reluctance to talk about work exposures and they do not record occupational information on the health record. They described that in their communities, farmworker women frequently present for prenatal care in the first trimester while they are Medicaid eligible. Health provider knowledge of occupational exposures, including pesticide exposures was limited.

Aim 2: Assess the extent of exposures to heat, ergonomic stress and chemical exposures that have the potential to impact pregnancy outcomes in a subsample of our study population:

The farmworkers commonly reported strenuous work activities, including frequent bending, lifting, and prolonged standing. The majority of workers reported working during their most recent pregnancy, with 40-50% working the entire pregnancy. Heat related symptoms varied across agricultural communities with fernery workers more likely to report symptoms than nursery workers. Compared to fernery workers, nursery workers reported better access to work-related hygiene amenities including clean drinking water and onsite bathrooms with a place to wash hands.

Perceived exposure to pesticides was negatively associated with biomarkers of pesticide exposure in urinary samples. Women working in ferneries were much more likely to believe that they had everyday contact with pesticides while at work (74.3% vs 26.7%) and were more likely to worry about the effects of pesticides on their health. However results of our urinary biomarker analysis revealed that pesticide metabolites were higher in the nursery workers. The difference was observed for two types of pesticides, organophosphates and a commonly used fungicide. Nursery workers who reported that they never had contact with pesticides in their workplaces had significantly higher levels of pesticide metabolites than those who believed they were exposed daily.

Preliminary analysis of our pregnancy history data reveals that the majority of farmworkers continue to work in agriculture while pregnant and that they vary on whether and when they tell their supervisors they are pregnant. Ninety-seven percent of women in our study reported receiving prenatal care, most seeking care in the first trimester. Pregnancy outcomes were similar between fernery and nursery workers, but fernery workers were much more likely to report that their children had been diagnosed with respiratory disease.

There is a great need for specific occupational training materials focusing on reproductive health risks associated with chemical, heat and musculoskeletal hazards. Our study used popular education techniques, a web-based interactive visual presentation, and video vignettes featuring local community members to reach low-literacy farmworker populations. Our evaluation showed a good level of content assimilation and suggestions for improving the format of the training. Training materials for health providers are also needed.

Aim 4: Disseminate lessons learned, study results and educational materials to farmworkers and the health and scientific community through farmworker community public forums, peer-reviewed journal articles, presentations at professional conferences and, and web-based publications:

Results of this study have had wide dissemination including scientific manuscripts, and presentations to both scientific and community audiences. We have made a total of 17 presentations of this work to scientific

(12) or clinical/stakeholder (5) audiences. In addition, the results of our work have been shared with our community advisory board and farmworker groups participating in the project.

Translation of Findings:

The CBPR nature of this study puts a strong emphasis on translation. Throughout the study we communicated our findings to our community advisory board, and also to farmworkers in the communities that participated in the work. We also did a number of presentations to the larger stakeholder community including professional occupational health and safety professionals and clinicians who care for this population. The results of this study pointed to specific ways that the education of the health provider community can be improved. We also identified barriers in the workplace that prevent farmworkers from implementing behaviors that are protective of their reproductive health. The results of this work also point out the need to include information about reproductive health risks as part of the mandated pesticide health and safety training required under the Worker Protection Standard to address the specific needs of pregnant farmworkers. In addition, the need for more farmworker training programs on heat related illness in general and specific hazards for pregnant women are highlighted by study results.

Outcomes/Impact:

This was a 4 year exploratory study with a strong partnership with a community-based, grassroots farmworker organization. In the collaboration with our community partners, we have submitted two grant proposals to: 1) examine the association between personal and work characteristics to the physiological response to heat and 2) examine the relationship between environmental exposure inflammation, oxidative stress, and pregnancy health among female farmworkers. Both of these future studies will use a CBPR format and will also expand the work to other agricultural communities in which the FWAF has a strong community presence.

Section 2

Scientific Report

1. Background:

Agriculture ranks as one of the three most hazardous occupations in the United States and while the majority of farmworkers are men, there are large numbers of women who work alongside their male counterparts in harvesting field crops and foliage. U.S. farmworkers are relatively young: in 2001-2002 the average age for both men and women was 33, therefore the reproductive issues of this workforce are an important area of occupational/environmental health research. The literature on the reproductive health of women who work has been sparse and inconclusive and reviews of reproductive health of pregnant farmworkers have been examined primarily for the potential of pesticide exposure. While the exposure to agricultural chemicals is a major occupational and reproductive hazard, other factors such as long periods of standing and exposure to heat and dehydration also have the potential to impact the health of pregnant farmworker women and their unborn children. Studies of reproductive health among farmworker populations are methodologically challenging given the number of environmental and occupational exposures that may occur, the multiple pregnancy and birth outcomes of interest and limitation in the size of the population available for study.

The farmworker community has consistently shown interest in the association between their work and the health of their children and there is a compelling need to develop culturally- and linguistically-appropriate educational materials to guide women and their families in assessing the potential effects of their work on their reproductive health. In this exploratory study we examined how female farmworkers assess the risks of certain environmental and occupational hazards, such as pesticide exposure, to pregnancy.

This community participatory research project was a collaboration between academic researchers from Emory University and the University of Florida and community researchers from the Farmworker Association of Florida and the Farmworker Health & Safety Institute who have extensive experience in community-based participatory research, education and organizing among farmworkers, scientific expertise in occupational exposures and clinical backgrounds in maternal health.

2. Specific Aims:

The overarching aim of the project was to advance our knowledge of the extent of exposures that occur in farm work that could have the potential to affect the health of pregnant women and to develop culturally- and linguistically-appropriate educational programs to increase the knowledge of pregnant working women and ultimately the health of their offspring. The specific aims of the project were to:

- Examine current perceptions of work hazards and pregnancy health among female farmworkers working in nursery and fernery operations in Florida,
- Assess the extent of exposures to heat, ergonomic and chemical exposures that have the potential to impact pregnancy outcomes in a subsample of our study population,
- Develop culturally and linguistically- appropriate educational materials emphasizing health promoting and protective behaviors during pregnancy for female farmworkers, and
- Disseminate lessons learned, study results and educational materials to farmworkers and the health and scientific community through farmworker community public forums, peer-reviewed journal articles, presentations at professional conferences and, and web-based publications.

3. Methodology:

A community-based participatory research study was conducted to advance our knowledge of the extent of exposures that occur in farm work that could have the potential to affect the health of pregnant farmworkers and their babies. We used focus group methodology to examine current perceptions of work risks and hazards and pregnancy health among female farmworkers in two agricultural communities in Florida. A survey of a cross-section of child-bearing age women was conducted to describe the nature, types and prevalence of work-related risk factors that could affect pregnancy outcomes. Exposure assessment techniques were used to measure the pesticide exposures of the women in our sample. We developed a culturally and linguistically appropriate agricultural healthy pregnancy training module (in English, Spanish and Creole) using the popular education method of training, and we piloted its effectiveness with a sample of farmworker women of child-

bearing age. Throughout all four years of the study we disseminated our study findings among the community stakeholders.

3.1 Setting and Targeted Communities: The Farmworker Association of Florida, Inc. (FWAF) is a membership organization of over 10,000 farmworker families from predominately Mexican, Haitian, African-American, Guatemalan and Salvadoran communities. It began in 1983 and was incorporated in 1986 with the goal of building a strong, multi-racial and economically viable organization empowering farmworkers to respond to and gain control over the social, political, economic, workplace, health and environmental justice issues that affect their lives. The members of FWAF work mainly in ferns, foliage, citrus, vegetables, sod, and mushrooms and reside in 15 counties throughout the state. We focused on females employed in nursery and fernery operations in the rural agricultural communities in Orange and Lake Counties near Apopka, Florida and in Volusia and Putnam Counties near Pierson, Florida. These workers are primarily Hispanic, but there were also groups of Haitian and African American workers in the nursery industry.

3.2 Focus Groups and Development of Survey: We conducted focus groups with groups of female nursery and fernery workers and indepth interviews with health providers providing care to pregnant women in the targeted communities. Focus groups are methods by which a researcher can elicit open-ended responses related to experiences, perceptions, behaviors, and knowledge which provide greater depth and richness than quantitative data affords. The focus groups with farmworker women were conducted in Spanish or Creole, audio-recorded, then translated as they are transcribed in English. We explored female farmworker knowledge and beliefs regarding the risks and hazards of their work and work-related factors that they felt could influence their pregnancy and fetal health. A focus group guideline was developed to frame the focus group discussions. Main discussion areas included those listed below:

1. What are some things at the worksite that you think could be dangerous to a pregnant woman?
2. How are these things dangerous?
3. How can pesticides affect a pregnant woman?
4. What would you recommend to a woman who is pregnant or could become pregnant to protect herself from dangers at the worksite?
5. Which of these things do you do regularly to protect yourself?
6. Of the things you do not do, what makes it hard to do these things?

Results from farmworker focus groups were later used to develop a survey and also inform a curriculum focused on farm work and pregnancy health.

The interviews with the health providers in the community explored their knowledge of the work that is done in the nurseries and ferneries and the hazards that are of particular concern for pregnant women. Recruitment of health providers was conducted by Dr. Maureen Kelly, a nurse midwife in consultation with FWAF, building on the contacts the organization has already developed over the years with the local health care facilities serving our target communities, and was directed to individuals who are providing prenatal care to pregnant farmworkers. Main discussion areas were those listed below:

1. During what trimester do you usually see pregnant farmworkers for their first prenatal visit?
2. Do you believe that access to prenatal care is readily available in your area? Why or why not?
3. What advice do you give pregnant farmworkers about pesticide exposure during pregnancy?
4. What recommendations do you give pregnant farmworkers about standing, lifting and hot environments during pregnancy?
5. What types of problems do pregnant farmworkers present within your office? Do you see some conditions more frequently in farmworkers? If so what are they?

Knowledge gleaned from these interviews revealed the importance of farmworker women informing their health care providers about their occupations and the need for more information and training for health providers that serve farmworker communities on occupational risk factors to pregnancy health.

3.3 Pregnancy and Work Survey: In the second phase of our work we conducted a survey of farmworker women of childbearing age to examine knowledge and beliefs of work hazards and pregnancy health and to assess the extent of exposures to heat, ergonomic and chemical exposures among the population. To be eligible to participate in the survey, individuals needed to (1) be a female between the ages of 16 and 40; (2) have worked in an Florida nursery or fernery operation for at least six months prior to entry into the study; and

(3) be currently employed in a Florida nursery or fernery operation and have averaged at least 20 hours of work per week over the previous 60 day period.

Development of the Survey Instrument: A survey instrument was developed and piloted using 1) information gleaned from our focus group data; 2) previous surveys that we have used to measure beliefs, knowledge, and practices related to pesticide exposure; and 3) components of published surveys containing items on reproductive worker health, ergonomics and heat exposure. The survey instrument was translated into Spanish and Haitian Creole and pretested among Haitian nursery workers and Hispanic nursery and fern workers.

Recruitment: We used a snowballing process to recruit our sample with recruitment efforts taking place in community events, through FWAF programs, and at other community locations frequented by female nursery and fernery workers. Female interviewers were recruited from FWAF and from target communities. All interviewers were trained in protection of human subjects and educated about the project and the surveying goals, how to administer informed consent and research surveys, how to track attempted and completed interviews, and how to document subject responses. Senior staff observed interviewers during the training period and periodically during the field work to assure appropriate survey practice and documentation.

Enrollment of Participants: In the consent process we explained that we are studying the experience of being pregnant and working in nursery and fernery operations and that we are determining the major concerns that pregnant women or women who could become pregnant have about their work and the health of their baby. All consents and questionnaires were administered in English, Spanish, or Haitian Creole depending on the preference of the study participant. No identifiers were obtained on the survey instrument. Each participant was given $25 for her time participating in the study. Each participant was also given information on health providers in her community providing prenatal care and the "*Your Work and Your Health*" information sheet developed by FWAF and the Farmworker Health and Safety Institute to help farmworker recognize signs and symptoms of pesticide exposure and how to protect themselves.

Data entry and analysis: Data cleaning was done by data analysts who inspected and corrected all erroneous entries. Descriptive statistics was used to assess in an exploratory manner the distribution of responses on survey items and the extent of missing data and outlier data. We compared responses on the survey between fernery and nursery workers to determine if they differ significantly on hours worked, work practices, the use of protective clothing, perceived exposures to pesticides, heat exposure and exposure to ergonomic hazards. We also compared survey responses of older women (over the age of 30) and younger women and whether ever being pregnant modifies work practices or exposures. Given the exploratory nature of this proposed work, no specific study hypotheses were being tested *a priori*.

3.4 Exposure Assessment: At the time of the survey all pregnant women and a random sample of the remainder of the participants were asked to participate in providing urine samples for analysis of pesticide metabolites for a total of 100 urine samples, 50 from each study area. These study participants were asked to provide a spot urine sample for analysis of pesticide biomarkers and received an additional $25 for participating in this phase of the research.

Specimen Collection and Transport: Single void (spot) urine samples were collected from the study participants at the time that the survey questionnaire was administered. All spot samples of urine for each participant were collected at approximately the same time of day (6-8 PM) from all participants. Samples were transported on ice to the study facility, and prepared for shipping on dry ice to the laboratory facility at the University of Pennsylvania. Upon receipt in the laboratory, samples were divided and stored at -80°C in tubes without any additives.

***Urinary Analysis for Pesticide* Metabolites:** We measured urinary dialkylphosphate (DAP) metabolites and Ethylenethiourea (ETU), the metabolite of a fungicide mancozeb commonly used in agriculture. The 5 dialkylphosphates were analyzed by gas chromatography (GC) with pulsed flame photometric detection (PFPD): dimethylphosphate (DMP), diethylphosphate (DEP), dimethylthiophosphate (DMPT), diethylthiophosphate (DETP), and dimethyldithiophosphate (DMDTP).

Statistical Analysis of Pesticide Metabolites: Standardization of the pesticide metabolites to creatinine were performed in the statistical analysis by including creatinine as a covariate. Non-detectable levels of each metabolite were replaced by one-half the level of detection for the measurement in question. The molar equivalent concentration of the DAPs were summed to create a summed DAP measure. Raw data were summarized using the median and inner-quartile range and log-transformed (to improve symmetry and mute

the effect of outliers) prior to further analysis. The magnitude of the differences were compared between fernery and nursery groups and by the type of work being performed at the time of the urine sample.

3.5 Curriculum Development: The Farmworker Health & Safety Institute developed a training curriculum that I incorporated information gleaned from our study participants, health providers, and other stakeholders. We drew upon insights obtained from focus groups and our farmworker survey, that identified the issues that workers understand well (which need little reinforcement) and those about which they lack knowledge.

The curriculum and materials built upon the curriculum that we have used and tested in past research on pesticide safety and worker protection, but was tailored to the needs of pregnant farmworker women and expanded to include heat stress and ergonomic and physical hazards associated with farm work. It was a pictorial-based curriculum with clear, evocative images understandable to women with limited formal education. The written portions, written in Spanish and Creole, were kept to a minimum.

Piloting the Curriculum: Team members were trained on the delivery of the Work and Pregnancy curriculum covering the hazard-specific information with the goal of training community members and developing their communication and leadership skills. The training was conducted using a popular education style which: (1) is highly participatory; (2) addresses issues the workers face in their own workplaces; and (3) builds upon their past experiences and knowledge. Extensive use was made of role plays, small group discussions and hands-on demonstrations, so that the participants could fully absorb the information presented and gain practice at answering the questions they are likely to face in the community. The trainers from the Farmworker Health & Safety Institute provided team members with accurate information and culturally appropriate practical solutions to convey to community members through the curriculum.

Target Population of Pilot Intervention: We recruited female nursery and fernery workers who did not participate in our previous focus groups and surveys, and are between 18 and 40 years of age to participate in the pilot of the farmworker healthy pregnancy training module. All educational sessions were held on weekends at the FWAF offices in Apopka and Pierson. We conducted in-depth interviews with a subsample of farmworkers who participated in the pilot of the curriculum to qualitatively evaluate the effectiveness and appropriateness of the participatory educational intervention. The interviews were taped recorded, transcribed in Spanish or Creole, and then translated into English.

3.6 Dissemination of Knowledge to the Community: A major focus of the project partners throughout was to disseminate the lessons learned, study results and educational materials to farmworkers and the health and scientific community through farmworker community public forums, peer-reviewed journal articles, presentations at professional conferences, and web-based publications.

3.7 Community Participation: Female nursery and fernery workers played many key roles in the design, implementation and evaluation of this project, serving as advisors, peer educators, interviewers, and reporters to the community. Focus group respondents were invited to attend feedback sessions where recurring issues were presented and paired with relevant interview excerpts in an effort to illustrate the overarching themes and conclusions. Respondents' reactions and feedback to the data collection results were solicited and used to inform the development of the training curriculum and the research conclusions.

3.8 Community Advisory Committee: We convened two Community Advisory Committees, representing community stakeholders in the two agricultural areas in the study area. In choosing our Advisory Committee members, we looked for individuals with knowledge of and/or a stake in their community. In recruiting grassroots leaders, formal education and the ability to read or write English, Spanish, or Creole was not a prerequisite. Rather, committee members distinguished themselves by their strong desire to help their community overcome serious obstacles to achieve work safety and healthy pregnancies. Members of our advisory committee in Apopka included: Marie Francois, Ellen Geiger, Marie Michelle Jean-Gilles, Yesica Ramirez, Blanca Moreno, Maria Cirrilo, Ana Luisa Trevino, Joan Flocks, Antonio Tovar, Jeannie Economos, Advisory committee members in Pierson included: Kay Hanis, Bert Perry, Lenor Aguilar, Consuelo Arrellano, Camelia Frias, Antonio Tovar, Joan Flocks, and Jeannie Economos.

3.9 Project Evaluation: A CBPR logic model below was used to guide focus groups, survey and exposure phases, curriculum development, evaluation measures, and expected outcomes of the project while maintaining the community-based principles. The logic model presents the association between the situations

that can potentially influence pregnant farmworkers' health, the specific inputs and outputs of project activities, and expected outcomes such as changes in knowledge, behavior, and biological measures of pesticide exposure. CBPR principles acknowledge that by creating partnerships among research and community partners, and building the leadership capacity and knowledge of community members through participatory approaches, health will improve. Accordingly, it was hypothesized that the focus groups and surveys, paired with linguistically and culturally appropriate materials, will influence farmworker women's knowledge, beliefs and practices to improve health during pregnancy. Throughout the design and implementation of the model components, project partners closely monitored issues of shared governance, equitable resource allocation, and shared benefits and burdens of participation.

Logic Model of Program Implementation and Evaluation

Situation/Priorities	Inputs	Outputs	Short Term Outcomes	Long Term Outcomes
Work situations that could affect the health of pregnant female farmworkers and their babies, including workplace ergonomic/heat stress and pesticide exposure Lack of linguistically and culturally-appropriate safety training materials for farmworkers of reproductive age Low access to services, including prenatal health care Discrimination, lack of political voice at work site among farmworkers Lack of health care providers who can provide education on pregnancy health Uncertainty regarding health effects of low-dose, cumulative exposure to pesticides	Multilingual staff and project partners History of collaboration among participating institutions Community organizations Expertise of research and evaluation team Community Advisory Committee (CAC) Community members and other farmworkers Communication and trust-building among partners Funding and support Expressed needs and priorities of workers in focus groups	Assess farmworker needs and priorities using focus groups Enroll approximately 50 study participants in Year 1 and conduct a survey of 250 workers in Years 2-3 Develop and refine data collection instruments based on community input Train project staff and community on data collection methods Analysis/report of survey findings and biological samples Develop local leadership Develop educational and outreach program and materials Disseminate educational materials using community workers Share study results and educational materials in journals and presentations	Increased awareness and knowledge about occupational safety and health during pregnancy Changed beliefs about work factors affecting pregnancy Increased self-reported health-protective behaviors during pregnancy Increased cohesiveness of community Increased research skills and capacity of community	Influence public policy regarding appropriate occupational safety and training policies for pregnant farmworkers Increased community capacity for change Empower the community to address other health concerns. Dissemination of training materials to other farmworker communities

Evaluation engaged all project partners and was used to strengthen the project activities and measure progress towards the specific aims of the study. Data collection methods included: surveys, urine specimen collections, tracking of recruitment and meeting attendance, exploratory focus groups with farmworkers and health providers, in-depth interviews with project partners and members of the community advisory committee, logs of peer educator activities, and minutes from meetings. Towards the end of the project, it became

apparent that the evaluation process for assessing the community engagement and participatory action of the project was very fluid and that no one person had been systematically charged with collecting and synthesizing evaluation data. Therefore in the last year of the project a formal evaluator joined the project to assess:

- *Collaboration:* focuses on connectedness, functioning as a team, cooperation, mutual respect
- *Communication*: focuses on ability to share and access thoughts and information freely
- *Conflict Resolution*: focuses on sharing and addressing problems between partners or sets of partners
- *Community Based Participatory Research approach:* focuses on shared governance, equitable resource allocation, shared benefits and burdens, and capacity building or community impact

Ultimately, the study team wanted to know "how well did we do and what difference did it make?"

4. Results

Aim 1: Examine current perceptions of work hazards and pregnancy health among female farmworkers working in nursery and fernery operations in Florida

In partnership with the community, we conducted focus groups with farmworker women and community representatives and structured interviews with health providers caring for pregnant farmworkers.

We published a manuscript focused on perceptions of heat exposure in farmworker women (Flocks et al., 2013) that described our focus groups with 35 farmworker women employed in nursery and fernery operations. When asked what kind of health problems were experienced related to heat at the workplace, nursery and fernery workers mentioned similar symptoms: headaches, dizziness/fainting, respiratory problems, vomiting, and exacerbated high or low blood pressure. Less frequently mentioned were sunstroke and heart attacks. Workers also mentioned other problems indirectly related to heat, including excessive sweating, skin irritation, rashes, itching, eye irritation, and even vaginal infections. The most commonly mentioned health impact was that pregnant women working in extreme heat are more prone to dizziness and fainting. Workers also mentioned that the heat can exacerbate a pregnant worker's pre-existing low or high blood pressure issues. Workers expressed varying perceptions about the impact of heat on a developing fetus. Many believed that heat can cause a fetus to become agitated, resulting in increased fetal movement and possibly increased fetal heartbeats. Some women said a fetus could "drown from heat" and others pointed out that if a woman becomes dehydrated from not drinking enough water in extreme heat, the fetus will also suffer dehydration. When asked how workers, and particularly pregnant workers, could protect themselves from the heat, many workers initially said there was no way to do this. After further reflection, some women said that drinking a lot of water or Gatorade helped, as did wearing a hat, taking breaks, and using a fan or sunblock. Participants reported beliefs that pesticide and heat exposures can adversely affect general, pregnancy, and fetal health, yet felt they lacked control over workplace conditions and that they lacked training about these specific risks.

These same farmworkers' perceptions of the risk of pesticide exposure and pregnancy health were published in the *Journal of Immigrant and Minority Health* (Flocks et al., 2012). When asked how pesticides specifically affect women of childbearing age, workers mentioned some of the same general pesticide-related symptoms such as headaches, dizziness, neurological effects ("shaking"), nausea, and nose and throat irritation. Fernery workers also mentioned infertility and rashes in the genital area caused by working in wet conditions. The workers were able to describe their perceptions of the risk of pesticide exposure to their offspring. For example, a fetus could be affected by the mother's pesticide exposure because a fetus absorbs everything that the mother absorbs. Some workers felt that pesticide exposure could cause miscarriages. Several women said they or someone they knew had experienced a miscarriage believed to be related to workplace chemical exposure. They also believed that a baby born to a woman exposed to chemicals at the workplace was at risk for birth defects and developmental disabilities. Many of the workers had children or knew of children born with these issues. The women also described that pesticides could cause sterility in men and that pesticides could cause infections in the male genital area and that these infections could be sexually transmitted to women. Some believed that chemicals could contaminate a man's blood and that he could genetically transmit the impact of this contamination to a fetus.

We also published the results of our structured interviews with 8 health providers (Kelley et al., 2013) that reported little information is shared about occupation during prenatal visits and that immigration factors can influence health-seeking behavior. With one exception, health care providers reported that they did not routinely record occupational information for the prenatal record. Although not recorded in the provider record, the clinicians reported that they saw pregnant farmworkers for the first visit between 9 and 24 weeks' gestation. Health providers indicated an overall awareness of pregnant farmworkers in the system but no particular attention to occupational risk assessment or health education. Regarding barriers to prenatal care, the

providers reported adequate translation services in their offices, although they acknowledged that the optimal situation would be for the provider to be bilingual, as one provider was. From the providers' perspective, transportation to the clinic or the ability to take time off from work were not identified as barriers to participating in prenatal care. Knowledge of occupational exposures, including pesticide exposures was limited. The Migrant Clinician Network chose to highlight this information and reprint this article in their member newsletter in Winter 2014 (*MCN Streamline*, 2014). The information gleaned from this formative work was used to develop a survey questionnaire that was conducted with a larger sample of women aimed to assess the extent of exposures to heat, ergonomic and chemical exposures that have the potential to impact pregnancy outcomes.

Aim 2: Assess the extent of exposures to heat, ergonomic and chemical exposures that have the potential to impact pregnancy outcomes in a subsample of our study population:

In year 2 of the project community health workers administered our cross-sectional survey to 260 female farmworkers between the ages of 19-40 working in ferneries (n = 144) or nurseries (n = 116). We also examined organophosphate pesticide metabolites and a metabolite of a common fungicide commonly used in agriculture (mancozeb) in a subsample of 100 farmworker women who completed the survey and 30 women living in the same communities, but not employed in agriculture. Our first publication on this work was published in the *Journal of Occupational and Environmental Medicine*, and a second manuscript in is progress. We highlight the results from this phase of work.

Workplace conditions. The farmworkers commonly reported strenuous work activities, including frequent bending, lifting, and prolonged standing. The majority of workers reported working during their most recent pregnancy, with 40-50% working the entire pregnancy. Working in the heat/sun was more prevalent among fernery workers (95.8%) compared to nursery workers (40.5%). Compared to nursery workers, fernery workers reported higher frequencies of the symptoms linked with heat exposure (heat, muscle cramps, nausea, dizziness, weakness, and fatigue). Nursery workers reported better access to work-related hygiene amenities including: access to clean drinking water and an onsite bathroom with a place to wash hands than women employed in fernery operations.

Actual versus Perceived Exposure to Pesticides. In Runkle et al., 2013 we described our findings regarding self-reported perceptions of exposure to pesticides (Runkle et al., 2013). Women working in ferneries were much more likely to believe that they had everyday contact with pesticides while at work (74.3% vs 26.7%). Among nursery workers, 37.9% believed they were never exposed to pesticides at work compared with only 1.4% of fernery workers. Women in nursery operations worried much less frequently about the effects of pesticides on their health than in fernery operations. We measured urinary organophosphate (OP) and fungicide metabolite levels in a subsample of 100 farmworkers (n=50 nursery, n=50 fernery, and n=30 non-agricultural control group). Overall, geometric mean concentrations for DMTP, DETP, and summary OP metabolite levels in nursery workers were significantly higher than levels detected in fernery workers and the control group. Mean Ethylenethiourea (ETU) in urine levels for nursery workers were three times the mean for fernery workers. Nursery workers who reported that they never had contact with pesticides in their workplaces had significantly higher levels of OP urinary metabolites (GM = 83.10 µg/g Cr) than nursery workers who reported they were exposed daily (GM = 46.53 µg/g Cr) ($P < 0.05$). We detected a marginally significant difference between women in fernery operations reporting daily exposure (GM = 35.16 µg/g Cr) compared with women who perceived never being exposed to pesticides (GM = 24.99 µg/g Cr) ($P < 0.10$). A similar trend was apparent in ETU metabolite concentrations.

Pregnancy histories. We are currently preparing a manuscript on our major findings regarding the pregnancies of our study sample and any differences observed among workers in nurseries compared to fernery operations. Of the 260 farmworker women we surveyed, 170 reported previously being pregnant. On average, female fernery workers worked in agriculture longer than their nursery worker counterparts (10.7 years vs. 7.1 years, respectively) (χ^2=18.9, p<.0001). The majority of women in both groups reported working in agriculture during their most recent pregnancy. More women working in fernery operations (76.9%) reported the father of the baby also worked in agriculture compared to women in nurseries (16.7%) (χ^2=48.2, p,0001).

Compared to nursery workers, fernery workers were less likely to report being pregnant to their supervisors (χ^2=10.9, p<.001) and when female fernery workers did tell their supervisors, they waited almost a month longer than nursery workers (t-value=2.43, p 0.02). Ninety-seven percent or more of women in our study reported receiving prenatal care. Nursery workers reported entering prenatal care at 11.5 weeks and fernery workers at 11.6 weeks (t-value=-.04, p=0.96). Fernery workers were more likely to be asked by a healthcare worker to alter their work routine (χ^2=11.9, p<.001) and were more likely than nursery workers to adhere to

physician-suggested work alterations by decreasing their work hours (fisher exact, p=.02), taking more frequent breaks (χ^2=13.8, <0.001), and sitting more than standing at the workplace (fisher exact, p 0.02).

There were no significant differences between nursery and fernery workers in report of maternal diagnosis of high blood pressure (fisher exact, p=0.38), diabetes or high blood sugar (χ^2=1.12, p=0.28), or premature labor (χ^2=0.09, p=0.76) experienced during pregnancy. Women were also asked to report on health symptoms experienced during their last pregnancy. Compared to nursery workers, a larger proportion of women working in ferneries reported that during their most recent pregnancy they experienced nausea (69.2% compared to 30.8%,χ^2=13.8, p 0.05), eye irritations (90% compared to 10%, fisher exact, p= 0.01), and throat irritations (88.9% compared to 11%, fisher exact, p=0.02).

We did not observe a statistically significant difference between occupational groups in the most recent pregnancy outcome, i.e. rate of live births, miscarriages (fisher exact, p=0.73), preterm births (χ^2=0.02, p=0.88), or birth defects (χ^2=0.01, p=0.94). Approximately 1 in 4 women working in ferneries reported their child had been diagnosed by a health care provider with a chronic health problem, including respiratory or breathing problems, and psychological or learning problems (χ^2=6.5, p=.01). Women were also asked to provide details about the child's diagnosed health problems. While female farmworkers reported an array of conditions, including asthma, developmental delays, and genetic abnormalities, the majority of self-reported health conditions related to respiratory illness. When examining mother's binary self-report of respiratory illness (yes/no), we found that fernery workers were 4.7 times more likely to report a child diagnosis of respiratory illness compared to women working in nurseries (17.6% compared to 5.7%, χ^2=4.2, p=.04). The manuscript describing these findings on pregnancy history and maternal and infant health outcomes is in preparation.

Pilot Study on Workplace Heat Exposure. In addition to surveying farmworker women on their exposure to heat, heat-related symptoms and measures they can take to reduce heat exposure while working we obtained supplemental funding (Emory University and the University of South Florida) to conduct pilot work on the feasibility of characterizing environmental,physiological and personal factors associated with heat-related illness in agricultural workers. In close partnership with the FWAF we studied 13 men and 31 women from the population of fernery workers working in Central Florida during the months of July and August 2012 and 2013. Physiologic measurements included body composition, simultaneous heart rate and intestinal core body temperature, work intensity, hydration and self-reported HRI symptoms over a 3-day study period. To assess acceptability, farmworker participants also completed an exit survey. We demonstrated the ability to obtain baseline physiologic measurements prior to beginning a work shift and post workday measures. Participant exit surveys indicated high acceptability of study methods, equipment and willingness to recommend participation in similar studies to other workers. This pilot data demonstrates the significant community engagement around issues of workplace exposures that can affect the health of farmworkers and the ability to engage the workers in study protocols that require sequential testing methods and follow-up. The results of this pilot work were incorporated into an R01 application to NIOSH that was recently reviewed, receiving an outstanding peer review score.

Aim 3: Develop culturally and linguistically- appropriate educational materials emphasizing health promoting and protective behaviors during pregnancy for female farmworkers:

A major focus of the project was on the development of culturally and linguistically- appropriate educational materials emphasizing health promoting and protective behaviors during reproductive years for female farmworkers. Our focus groups, survey and biomarker results and feedback from our community advisory board were used to guide the development of a comprehensive curriculum targeting female farmworkers of reproductive age.

Our curriculum integrated information on pregnancy and work-related health hazards (heat and heat-related illness, ergonomic stress, and pesticides) into general information that all women of child-bearing age need regarding optimal reproductive health. Guided by a community advisory board, the project team translated research results into an accessible final product, yielding an evidence-based training combining workers' knowledge with information on pregnancy health, pesticide safety, heat stress, ergonomic risk factors, and prevention measures. Research results incorporated into the training include organophosphate and fungicide exposure levels and qualitative data on pregnancy and workplace hazards and farmworker patient-doctor relations. The curriculum was pilot-tested using popular education techniques, web-based interactive visual presentation, and video vignettes featuring local community members to reach low-literacy farmworker populations. A total of 4 pilot workshops with an average of 9 women in each workshop were conducted for a total of 37 women who work in agriculture. Evaluation was performed using (1) role-play to test content

assimilation and (2) focus groups to query about the delivery process. Following curriculum implementation, participants were asked to break up into small groups to act out and apply new information in staged but potentially real-world scenarios. Role-play analysis showed a good level of content assimilation; whereby women demonstrated their newly acquired knowledge and resources to devise action plans, implement injury-prevention strategies, and provide assistance to workers in need. Focus group participants reported receiving valuable information and learning new content; pesticide information was rated the most useful. Participants suggested the length of the training be modified, so trainers revised and reduced it from 3.5 hours to less than 2.5 hours. The training is available in English and Spanish and can be conducted online or onsite, according to technical capability. Because it is available in an electronic format online dissemination and distribution is easy, cost-effective and can be modified to fit other fields. Curriculum follow-up evaluation focus group results showed that participants found the blend of training methods to be effective and that the sociodramas fostered collaborative and collective action and sharing of information learned.

Aim 4: Disseminate lessons learned, study results and educational materials to farmworkers and the health and scientific community through farmworker community public forums, peer-reviewed journal articles, presentations at professional conferences and, and web-based publications:

Our project had a strong emphasis on the dissemination of lessons learned, study results and educational materials to farmworkers and the health and scientific community through farmworker leadership committee meetings, peer-reviewed journal articles, and presentations at professional conferences. We have been actively involved in disseminating the educational materials and presenting our approach to research translation.

We have 4 publications (and one reprint) to date that are listed in a separate section of this report. We have made a total of 17 presentations of this work to scientific (12) or clinical/stakeholder (5) audiences. In addition, the results of our work have been shared with our community advisory board and farmworker groups participating in the project. The list of presentations follows:

1. McCauley, L., Kelley, M., Economos, J., Flocks, J. & Carrasquillo, N. "Using Community-Based Participatory Research to Assess and Address Job-Associated Hazards in Female Farmworkers in Florida" (poster presentation). Inaugural Partnerships for Environmental Public Health Program Meeting, Research Triangle Park, North Carolina, April 26-27, 2010.
   Description: Update grantee on progress of year 1 of the project.
   Audience: Scientific
2. McCauley, L., Kelley, M., Economos, J., Flocks, J. & Carrasquillo, N. "Using community-based participatory research to assess and address job-associated hazards in pregnant farmworkers in Florida." Poster session presented at the 1st Annual NIOSH Occupational Health Disparities Conference, Chicago, IL, USA, September 2011.
   Description: Discuss the importance of using participatory research methods to address occupational health disparities for vulnerable agricultural populations.
   Audience: Scientific
3. McCauley L., Flocks J., Economos J., Kelley M., and Tovar A., "Using Community-Based Participatory Research to Assess and Address Job-Associated Hazards in Pregnant Farmworkers", American Public Health Association Annual Meeting, Washington, DC, October 31, 2011.
   Description: Discuss the importance of using participatory research methods to address occupational health disparities for vulnerable agricultural populations.
   Audience: Scientific
4. McCauley, L., Kelley, M., & J., Flocks, J. "Pregnancy Health Among Florida Farmworkers". Workshop presented at the 24th Annual East Coast Migrant Stream Forum in West Palm Beach, FL, USA, October 2011.
   Description: Discuss the importance of considering the impact of workplace conditions and exposures on pregnancy health for vulnerable female farmworkers.
   Audience: Clinicians
5. McCauley, L. "Pregnancy Health Among Florida Farmworkers" Oral presentation at Wake Forest University Farmworker Research Team. Winston-Salem NC, USA, November 2011.
   Description: Discuss the importance of considering the impact of workplace conditions and exposures on pregnancy health for vulnerable female farmworkers.
   Audience: Scientific

6. Tovar-Aguilar, A., Economos, J., Trevino, A., Higgins, M., Mac, V., Flocks, J., Kelley, M. & McCauley, L. " Characterization of Hazardous Working Conditions for Female Farmworkers of Childbearing Age." Poster session presented at the NIEHS Partnerships for Environmental Public Health Annual Meeting, Bethesda, MD, USA, March 2012.

Description: Characterize workplace exposures with potential impact on pregnancy health for vulnerable female farmworkers.

Audience: Scientific

7. McCauley, L., Economos, J., Flocks, J., Mac, V., Tovar-Aguilar, A & Kelley, M. "Reproductive Hazards and Female Agricultural Workers." Poster session presented at the 30th International Congress on Occupational Health. Cancun, Mexico, March 2012.

Description: Characterize workplace exposures with potential impact on pregnancy health for vulnerable female farmworkers.

Audience: Scientific audience and clinicians

8. Economos, J. "Pregnancy Health Among Florida Farmworkers" Presentation to First Occupational Injury and Illness Coalition Partners meeting, Florida Department of Health. Tallahassee, FL, USA. September 2012.

Description: Characterize workplace exposures with potential impact on pregnancy health for vulnerable female farmworkers in Central Florida.

Audience: State health officials focused on occupational health and safety 9. McCauley, L. "Female Agricultural Workers: Ergonomic Hazards, Heat Stress, and Pesticide Exposures" Keynote Presentation. University of Cincinnati Pilot Research Projects Symposium. Cincinnati, OH, USA, October 2012

Description: Raise awareness of workplace exposures with potential impact on pregnancy health for vulnerable female farmworkers.

Audience: Scientific

10. Tovar-Aguilar, A., Economos, J., Trevino, A., Higgins, M., Mac, V., Flocks, J., Kelley, M. & McCauley, L. "Characterization of Hazardous Working Conditions for Female Farmworkers of Childbearing Age". Oral presentation session presented at the American Public Health Association Annual Meeting, San Francisco, CA, USA, October 2012.

Description: Characterize workplace exposures with potential impact on pregnancy health for vulnerable female farmworkers in Central Florida.

Audience: Scientific

11. Tovar A. & Flocks J. "Building Safety Strategies for Pregnant Farmworkers," Society for Applied Anthropology Annual Meeting, Denver, CO, USA, March 2013.

Description: Prevention strategies to reduce workplace exposures with potential impact on pregnancy health for vulnerable female farmworkers.

Audience: Scientific

12. Runkle J, Economos J, Tovar A, Flocks J, McCauley L. "Workplace exposure to fungicides: A Reproductive Hazard for Women Working in Agriculture". Poster presentation at the 141st APHA Annual Meeting 2013 meeting in Boston, MA, USA, November 2013.

Description: Discuss workplace exposures to potential reproductive toxicant and impact on pregnancy health for vulnerable female farmworkers.

Audience: Scientific

13. Tovar A, Economos J. "Pregnancy Health Among Florida Farmworkers". Presentation to Community Health of South Florida, Inc., Grand Rounds in Naranja, FL., USA, June 2013.

Description: Participatory action research and occupational safety to ensure pregnancy health for vulnerable female farmworkers.

Audience: State/local officials and community members

14. Runkle J, Flocks J, Tovar A, Economos J, McCauley L. "Occupational Exposure to Mancozeb: A Reproductive Hazard for Women Working in Agriculture." Poster presentation at the Reproductive Health 2013 meeting in Denver, CO, USA, September 2013.

Description: Discuss workplace exposures to potential reproductive toxicant and impact on pregnancy health for vulnerable female farmworkers.

Audience: Scientific

15. Mac V, Runkle J, Tovar A, Semple M, Economos E, McCauley L. "Feasibility of physiologic biomonitoring of occupational heat-related illness in central Florida farmworkers." Poster session at the 141st APHA Annual Meeting 2013 meeting in Boston, MA, USA, November 2013.

Description: Discuss workplace exposures to extreme heat and impact on health of vulnerable farmworkers.

Audience: Scientific

16. Tovar A, Economos J, Runkle J, Flocks J, McCauley, L. "Popular and Scientific Knowledge Translation to Reduce Occupational Risks among Female Farmworkers". Panel session at the Society of Environmental Toxicology and Chemistry North American 34th Annual Meeting. Nashville, TN, USA, November 2013.

Description: Discuss development and piloting of web-based educational curriculum targeting pregnancy health for vulnerable female farmworkers.

Audience: Scientific

17. Resende, R & Economos, J. "Pregnancy Health Among Florida Farmworkers". Presentation/training to Community Health of South Florida, Inc., Grand Rounds, Miami, FL, USA. December 2013.

Description: Discuss workplace exposures and impact on pregnancy health for vulnerable female farmworkers.

Audience: Clinicians

5. Discussion

5.1 *Project Evaluation Results*. This 4 year CBPR project illustrates the power of a community based participatory research approach to studying vulnerable working populations. The community participated in every stage of this research, from defining the initial problem, training community workers to participate in recruitment and data collection, examining all data with researchers and developing dissemination messages, and presenting the results to scientific and community groups. The group continues to work on grant applications that will continue to address occupational exposures and health outcomes in this community. Results from the final project evaluation using questionnaires and qualitative interviews with project partners and community advisory board members are described below. Broadly, the evaluation questions focused on informants' perspectives of the "four C's,": *Collaboration:* focused on connectedness, functioning as a team, cooperation, mutual respect*; Communication*: focused on ability to share and access thoughts and information freely*; Conflict Resolution*: focused on sharing and addressing problems between partners or sets of partners*; and Community Based Participatory Research approach:* focuses on shared governance, equitable resource allocation, shared benefits and burdens, and capacity building or community impact.

Responses to questionnaire items were overwhelmingly positive. For the most part, respondents indicated that they agreed or strongly agreed with statements designed to capture successful partnerships. Overall, questionnaire results point to a sense of mutual trust and respect as well as an appreciation for team dynamics. Comments primarily seem to indicate that even though there are some challenges, the positive aspects outweigh the negative and there seems to be a strong desire to continue working as a team. Rather like the questionnaire results, interview respondents were primarily pleased with the project and proud of their participation.

This work presents a significant contribution to our knowledge of female ***farmworkers' perceptions of pesticide exposure and pregnancy health.*** Focus group discussion revealed that farmworker women are aware of some of the basic safety information they may have learned at pesticide trainings from their employers, from FWAF or through other resources. When asked about ways a worker can protect herself against pesticide exposure, the focus group participants discussed many of the same protective behaviors that are recommended in pesticide health and safety trainings, including some that are included in the EPA-mandated training that is required under the Worker Protection Standard. Yet they also discussed the difficulties of and barriers to implementing these measures. For example, they stated that in order to protect against pesticide exposure, all workers, especially pregnant women, should wear long pants, long-sleeved shirts, plastic gloves, a hat, a mask, long socks, boots, and sometimes safety glasses, but they recognized that even when a worker covers herself completely, she can still be exposed. Clothing gets wet with moisture from the field or with sweat and wet clothing absorbs chemicals. Plastic gloves can tear, exposing the skin underneath. Protective equipment such as gloves and masks has to be replaced often and many employers do not provide these for their workers, thus workers have to purchase them with limited resources. Participants

recommended washing or cleaning hands frequently at the workplace—including before eating, and before and after using the bathroom. However, they also reported that in many worksites there is no water for hand washing or drinking and this can exacerbate the risks for pregnant women exposed to pesticides. If there is a source of water in a workplace, workers often do not know if the water is potable. To ensure they have safe drinking water at the worksite, workers recommended bringing their own covered water bottles from home.

Despite the general acknowledgement of increased heat related illness (HRI) risk for farmworkers and the national attempts to highlight this hazard, there are no specific educational materials for pregnant workers and there have been no studies assessing the specific needs of pregnant farmworkers in preventing HRI. Our study was a first step in promoting prevention of HRI in which we documented female farmworkers' beliefs about heat exposure and pregnancy outcomes. Female farmworkers consistently believe that heat exposure can adversely affect general, pregnancy, and fetal health, yet they indicate a lack of control over the conditions and receive no specific training about HRI, especially as it relates to pregnancy health. A lack of training may make it difficult for women to recognize the symptoms of HRI and differentiate them from other possible causes producing similar symptoms, such as pesticide exposure, flu, or – for pregnant women – morning sickness. These data enhance our knowledge and insight on how to better address heat as a specific occupational hazard in this population. We discovered that there was immense interest among the workers on the topic of HRI. In response to this interest we obtained supplemental funding in partnership with the NIOSH funded Education and Research Center at the University of South Florida to implement a feasibility study of obtaining environmental and physiological data on the extent of heat exposure in this occupational population.

One of the most challenging aspects of this project was the qualitative assessment of the **Health Care Providers' Perspectives on Female Farmworker's Health During Pregnancy.** Recruitment of a sample of health providers was difficult. Our community partner had limited access to this population. The midwife on our project, with assistance from the Migrant Clinician Network assisted us in identifying a small sample of providers. Though the sample was small the results greatly informed our study. As reported in the Results section, health care providers did not tend to collect or record occupational information at the time of first visit to a provider. Little information is collected about the work experience of pregnant farmworkers. This finding is consistent with a recent nationwide survey from the University of California San Francisco of 2,600 obstetricians and gynecologists, asking about risk assessment and health information for women who are pregnant. Most of the physicians did not warn their patients about chemicals in food, consumer products that could be dangerous, or environmental hazards to the fetus.

We were surprised at the high proportion of women who obtain prenatal care. Because of presumptive Medicaid eligibility in Florida, providers reported that all women had access to prenatal care if they present in the first trimester, although it might be episodic depending on immigration status. Some providers declined to see women who first presented for prenatal care in the third trimester, citing liability considerations for the clinician.

Regarding barriers to prenatal care, the providers reported adequate translation services in their offices, although they acknowledged that the optimal situation would be for the provider to be bilingual, as was one provider. From the providers' perspective, transportation to the clinic or the ability to take time off from work were not identified as barriers to participating in prenatal care. Concern was expressed about how immigration status might affect health-seeking behavior. This feedback from the providers may reflect a truly enlightened health care environment in the area, or the possibility that providers are not aware of the barriers some women face in the workplace. The literature seeking information from farm workers about barriers reports this to be a problem for at least some women.

The results reflect a lack of information among health care providers about occupational and environmental exposures, misinformation regarding who regulates agricultural pesticide use, and an expressed need by two providers for more training in this area. These findings are similar to those of the nationwide survey of obstetricians and gynecologists presented in the 2012 *Environmental Health News* report. In that study, 89% of the physicians interviewed said that guidelines from their professional organization, the American College of Obstetricians and Gynecologists, would be the most helpful way to gain information on environmental health.

One of the most surprising findings of this work was the association between **Pesticide Risk Perception and Biomarkers of Exposure.** The literature is replete with research documenting concerns of pesticide exposure among farmworkers. Nevertheless, a few studies have compared farmworkers' perceptions of exposure with biomarkers of actual exposure. Our results show that perceived pesticide exposure did not correspond to summary OP urinary metabolite levels within differing agricultural subpopulations. The significance of our findings demonstrates that risk assessment of pesticide exposure among farmworkers may

not correspond with actual biomarkers of exposure. The results of this work point to the difficulty for workers to actually know their actual exposure. Fernery workers consistently believed their exposures were high, while nursery workers felt they were not exposed. Interestingly the control sample from the same community where our nursery workers worked, also had higher levels of OP exposure than the fernery workers. These findings could be related to the proximity of residences to agricultural fields, exposure through other routes such as diet or residential pesticide use. The protected nature of greenhouses, could also delay the degradation of OP residues on plants, resulting in an increased risk of exposure in that population.

The levels of OP metabolites observed in these two Florida farmworker communities can be compared with other reported levels in agricultural communities. During the same year as the current study, male and female nursery workers were studied in Oregon. All metabolites for both these studies were analyzed in the same laboratory with identical analytical techniques. Results of comparison tests showed comparable summary DAP levels in the Oregon nursery workers (GM = 74.89; CI = 70.67–79.36) compared with summary levels detected in Florida nursery workers (GM = 56.96; CI = 52.19–62.16) ($P < 0.08$).

We were able to develop **culturally and linguistically- appropriate educational materials emphasizing health promoting and protective behaviors during pregnancy for female farmworkers.** We were able to pilot the educational program and to incorporate innovative technology into the popular education approach commonly used by community workers. There remain several distinct challenges/opportunities to continue this work. Examples of future areas of work include:

1. Adapting the training module into smaller units that could be used in other settings such as clinics, online access, smartphone applications etc.
2. Improving the methods of assessing the impact of the training on worker knowledge and beliefs. We explored the extent to which videotaping role-playing post training exercises could be quantified in some manner to assess engagement in learning, and extension of learning to intentional behavior change.
3. Identifying the types of educational platforms that are most useful to clinicians and developing specific training on heat exposure and musculoskeletal stress.
4. Addressing through health policy the lack of any information in the Worker Protection Standard on risks to pregnancy health and adaptations that are needed in the workplace.

6. Conclusions

Our strong partnership with community-based farmworker populations gives us a unique opportunity to partner with the workers to successfully address farmworker health and safety issues. In the collaboration with our community partners, we have submitted two grant proposals to: 1) examine the association between personal and work characteristics to the physiological response to heat and 2) examine the relationship between environmental exposure, inflammation, oxidative stress, and pregnancy health among female farmworkers. Both of these future studies will use a CBPR format and will also expand the work to other agricultural communities in which the FWAF has a strong community presence.

Inclusion Enrollment Report

Study Title: Pregnancy Health

Total Enrollment: 379 **Protocol Number:**

Grant Number: 1 R21 OH009830-01

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race				
Ethnic Category	**Females**	**Males**	**Sex/Gender Unknown or**	**Total**
Hispanic or Latino	334			334 **
Not Hispanic or Latino	42	3		45
Unknown (individuals not reporting ethnicity)				
Ethnic Category: Total of All Subjects*	376	3		379 *
Racial Categories				
American Indian/Alaska Native				
Asian		1		1
Native Hawaiian or Other Pacific Islander				
Black or African American	35	1		36
White	341	1		342
More Than One Race				
Unknown or Not Reported				
Racial Categories: Total of All Subjects*	376	3		379 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)				
Racial Categories	**Females**	**Males**	**Sex/Gender Unknown or**	**Total**
American Indian or Alaska Native				
Asian				
Native Hawaiian or Other Pacific Islander				
Black or African American				
White	334			334
More Than One Race				
Unknown or Not Reported				
Racial Categories: Total of Hispanics or	334			334

Publications:

1. Flocks J, Kelley M, Economos J, McCauley L: [2012] Female farmworkers' perceptions of pesticide exposure and pregnancy health. *J Immigr Minor Health.*14(4):626-32. http://www.ncbi.nlm.nih.gov/pubmed/22094390
**Manuscript publishes findings on Aim 1: Examine current perceptions of work hazards and pregnancy health among female farmworkers working in nursery and fernery operations in Florida.*

2. Jennifer D. Runkle, J. Antonio Tovar-Aguilar, Eugenia Economos, Joan Flocks, Bryan Williams, Juan F Muniz, Marie Semple, and Linda McCauley; [2013]. Pesticide Risk Perception and Biomarkers of Exposure in Florida Female Farmworkers. *Journal of Environmental and Occupational Medicine.* 55 (11): 1286-92.
**Manuscript publishes findings on Aim 2: Assess the extent of exposures to heat, ergonomic and chemical exposures that have the potential to impact pregnancy outcomes in a subsample of our study population.*

3. Joan Flocks, Valerie Vi Thien Mac, Jennifer D. Runkle, J. Antonio Tovar-Aguilar, Eugenia Economos, and Linda McCauley: [2013]. Female Farmworkers' Perceptions of Heat-related Illness and Pregnancy Health. *Journal of Agromedicine.*18 (4): 350-8.
**Manuscript publishes findings on Aim 1: Examine current perceptions of work hazards and pregnancy health among female farmworkers working in nursery and fernery operations in Florida.*

4. Maureen A. Kelley, Joan Flocks, Jeannie Economo, and Linda A. McCauley: [2013]. Female Farmworker's Health During Pregnancy: Health Care Providers' Perspectives. *Workplace Health & Safety.* 61(7): 308-13.
**Manuscript publishes findings on Aim 1: Examine current perceptions of work hazards and pregnancy health among female farmworkers working in nursery and fernery operations in Florida.*

5. Maureen A. Kelley, Joan Flocks, Jeannie Economos, and Linda A. McCauley: [2014]. "Female Farmworkers' Health During Pregnancy Health Care Providers' Perspectives." Workplace Health Safety 61.7 (2013): 308-313. Republished in MCN Streamline. 20 (1):16-20.
**Manuscript publishes findings on Aim 1: Examine current perceptions of work hazards and pregnancy health among female farmworkers working in nursery and fernery operations in Florida.*

6. Runkle J, Flocks J, & McCauley L. Work-place Risks, Pregnancy and Infant Health Outcomes in Florida Farmworkers. *IJERPH* (special issue on maternal & child health). In progress
**Manuscript will focus on findings on Aim 2: Assess the extent of exposures to heat, ergonomic and chemical exposures that have the potential to impact pregnancy outcomes in a subsample of our study population.*

Inclusion of Children

We did not recruit any children under the age of 18. Nine of our participants were under the age of 21.

Materials available for other Investigators

The data obtained in this study is generally available for other investigators seeking to replicate, or reproduce the work of this study. The materials that we can provide include:

1. De-identified transcripts of the focus groups with farmworker women and health providers are available upon permission of the FWAF. Audio-tapes are not available due to the potential risk that information may have been disclosed that would identify the participant.
2. The de-identified databases of the survey results are available along with body charts of locations of skin rashes and musculo-skeletal pain.
3. The urine samples are being stored for 5 years and de-identified samples are available upon request and approval from the FWAF.
4. Our study survey is available upon request.
5. The data from our heat feasibility study including survey, biological measures etc. are not available at this time.