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Pesticide Urinary Metabolites Among Latina Farmworkers and Non-Farmworkers in North Carolina

Thomas A. Arcury, PhD[a,b], **Paul J. Laurienti, MD, PhD**[c], **Jennifer W. Talton, MS**[d], **Haiying Chen, MD, PhD**[b,d], **Timothy D. Howard, PhD**[e,b], **Dana Boyd Barr, PhD**[f], **Dana C. Mora, MPH**[a,b], and **Sara A. Quandt, PhD**[g,b]

[a]Department of Family and Community Medicine, Wake Forest School of Medicine, Winston-Salem, North Carolina

[b]Center for Worker Health, Wake Forest School of Medicine, Winston-Salem, North Carolina

[c]Department of Radiology, Wake Forest School of Medicine, Winston-Salem, North Carolina

[d]Department of Biostatistical Sciences, Division of Public Health Sciences, Wake Forest School of Medicine, Winston-Salem, North Carolina

[e]Center for Genomics & Personalized Medicine Research, Wake Forest School of Medicine, Winston-Salem, North Carolina

[f]Department of Environmental and Occupational Health, Rollins School of Public Health of Emory University, Atlanta, Georgia

[g]Department of Epidemiology and Prevention, Division of Public Health Sciences, Wake Forest School of Medicine, Winston-Salem, North Carolina

Abstract

Objectives—This paper compares detections and concentrations of pesticide urinary metabolites for Latina farmworkers and non-farmworkers in North Carolina.

Methods—Thirty-one farmworkers and 55 non-farmworkers provided urine samples in 2012 and 2013. Urine samples were analyzed for detections and concentrations of organophosphate insecticide, bis-dithiocarbamate fungicide, and pyrethroid insecticide urinary metabolites.

Results—Detections for several organophosphate and pyrethroid pesticide urinary metabolites were present for substantial proportions of the farmworkers and non-farmworkers. Concentrations

Correspondence: Thomas A. Arcury, PhD, Department of Family & Community Medicine, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157-1084, tel: 336-716-9438, fax: 336-716-3206, tarcury@wakehealth.edu.

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for several of these metabolites were high. Farmworkers and non-farmworkers were similar in detections and concentrations for the pesticide urinary metabolites included in this analysis.

Conclusions—Participant pesticide exposure increases health risks for them and their children. Research needs to document pesticide exposure, its health effects, and ways to reduce it. Current information justifies policy development to reduce pesticide exposure in all communities.

Keywords

Pesticide exposure; women's health; immigrant health; minority health; health disparities; immigrant workers; environmental health; occupational health

Introduction

Migrant and seasonal farmworkers and the members of their families experience frequent pesticide exposure. Analyses of biomarkers document that farmworkers (generally men) experience repeated occupational doses of multiple pesticides across the agricultural season.[1–8] Biomarker analyses also document that women and children who live in farmworker households and communities frequently experience doses of multiple pesticides. [9–17] Finally, environmental evaluations indicate that a variety of pesticides are present in farmworker houses. [15,18–23]

Pesticide exposure is associated with adverse health outcomes among adults, and developmental outcomes among children. Acute intoxication has immediate and drastic effects,[24] which, depending on dose, range from rash, burning eyes, and muscle ache, to coma and death. The effects of long-term, lower dose exposure are often delayed and include increased risk for neurocognitive decline, pulmonary disease, cancer, and reproductive problems. Much of the research on these long-term effects has been conducted with licensed pesticide applicators through the Agricultural Health Study (https://aghealth.nih.gov/).[25] The documented effects of low-dose exposure on adult farmworkers are limited to cholinesterase depression,[26,27] and impaired olfaction.[28] Research also indicates that pre-natal[29–36] and post-natal[37–39] pesticide exposure among the children of farmworkers and others adversely affects their neurocognitive development.

Although women often work in the fields, few studies have focused on Latina farmworker pesticide exposure. Flocks et al.[40] examined the pesticide exposure beliefs of Latina farmworkers. Runkle et al.[41] compared women working in ferneries and nurseries, with controls (women not working in agriculture) and found high levels of detections and concentrations of the organophosphorus (OP) pesticide dialkylphosphate (DAP) urinary metabolites, and of ethylene thiourea (ETU), a bis-dithiocarbamate fungicide urinary metabolite, for both groups.

Pesticide exposure is also a concern for vulnerable non-agricultural communities in the United States (US),[30,36,42–44] as well as in other countries.[45–47] Assessments of pesticide exposure in non-agricultural US populations have focused on specific issues, such as prenatal and early life exposure and child development,[31,36,42,44] and reproductive health.[48–51] Pesticide exposure pathways in non-agricultural communities include pesticide residues on food,[52,53] environmental exposures due to residential pesticide application,[54] and non-agricultural occupational exposures.[55]

The aim of this paper is to describe the detections and concentrations of pesticide urinary metabolites for Latina farmworkers and non-farmworkers in North Carolina. The pesticide urinary metabolites include those for OP insecticides (the six DAPs, as well as the chlorpyrifos metabolite 3,5,6-trichloropyridinol (TCPY), the malathion metabolite malathion dicarboxylic acid (MDA), acephate (APE), and methamidaphos (METH)); bis-dithiocarbamate fungicides (ETU and propylene (PTU)); and pyrethroid insecticides (3-phenoxybenzoic acid (3PBA), and cis,trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylic acid (DCCA)).

Methods

Overview

This analysis uses data collected through a community-based participatory research collaboration that began in 1995 and includes the North Carolina (NC) Farmworkers Project (Benson, NC), which serves immigrant farmworkers in eastern NC; El Buen Pastor Latino Community Services, which serves the immigrant Latino community in Winston-Salem, NC; and Wake Forest School of Medicine. The Wake Forest School of Medicine Institutional Review Board approved the study protocol.

Population and Sample

We recruited Latina farmworkers in Harnett, Johnston, and Sampson Counties, which are in eastern NC. We recruited Latina immigrants not employed in agriculture in Forsyth County, which is located in west central NC. Participants were women aged 18 through 55 years who self-identified as Latino or Hispanic, and who spoke Spanish or English fluently. Latina farmworkers had to be currently employed in agriculture and to have worked in agriculture for at least three years. We excluded non-farmworkers with potential occupational pesticide exposure: those who worked in areas such as agriculture, forestry, landscaping, grounds keeping, lawn maintenance, and pest control in the past 3 years. We excluded potential participants if they were told by a healthcare professional that they had diabetes. The larger project, which investigated the effects of pesticide exposure on sub-clinical neurological health, dictated the requirements that participants did not have diabetes and non-farmworker participants did not have occupational pesticide exposure.[28]

The community partners assisted in recruiting participants by contacting them and referring them to the study if they met the inclusion criteria. A total of 86 Latinas, 31 farmworkers and 55 non-farmworkers, met the inclusion criteria and participated in data collection (completed interviews and provided a urine sample). Because community partners made the initial contacts with potential participants, we did not know the number of potential participants who did not agree to participate. All participants gave signed informed consent.

Data collection

Participants completed a baseline interview and attended a data collection clinic at which they provided a urine sample from June through November, 2012, and attended a second data collection clinic from July through November 2013. Participants received a $30 incentive for completing the baseline questionnaire, $30 for attending the first data collection clinic, and $30 for attending the second data collection clinic, for a maximum incentive of $90 across the two years of data collection.

Baseline interviews included items addressing the participant personal characteristics of age, education, country of birth, dominant language, and occupation. We developed the interview questionnaire in English and translated it into Spanish. We checked the Spanish and English versions for comparable meaning and adjusted item wording as needed. We pre-tested the questionnaire with several native Spanish speakers and made final corrections. Interviewers were native Spanish speakers who we trained. We managed the data using Research Electronic Data Capture (REDCap) hosted at Wake Forest School of Medicine.[56] REDCap is a secure, web-based application designed to support data capture for research studies.

Laboratory analysis

Participants provided a spot urine sample at each of the two data collection clinics. We prepared a 10 ml aliquot from each sample and froze the aliquot at −80°C until we could deliver it for analysis to the laboratory at Emory University, Atlanta, GA. The laboratory processed all of the samples at the same time; the laboratory was blind as to which samples were from farmworkers or non-farmworkers. The laboratory extracted and concentrated each sample using solid phase extraction. To ensure quality data, they analyzed additional quality control materials, fortified samples, and blank samples in parallel with all unknown samples.

The laboratory used the mass-spectrometry based method of Prapamontol and colleagues[57] to measure the six urinary DAP metabolites of OP pesticides: dimethylphosphate (DMP), dimethylthiophosphate (DMTP), dimethyldithiophosphate (DMDTP), diethylphosphate (DEP), diethylthiophosphate (DETP), diethyldithiophosphate (DEDTP). They thawed the urine samples to room temperature. They fortified a 1-mL aliquot of each sample with isotopically labeled internal standards. They extracted the urine samples with acetonitrile and diethyl ether and the DAP metabolites were chemically derivatized to their respective pentafluorobenzyl phosphate esters. The reaction mixture was concentrated, and the phosphate esters were measured using gas chromatography-MS in the single ion monitoring mode. Unknown analyte concentrations were quantified using isotope dilution calibration with calibration plots generated with each sample run. Limits of quantification were 0.3 μg/L for DMP, 0.2 μg/L for DMTP, 0.1 μg/L for DMDTP, 0.2 μg/L for DEP in 2012 and 0.1 in 2013, 0.1 μg/L for DETP, and 0.1 μg/L for DEDTP.

They measured TCPY, MDA, and 3PBA in each extract by high performance liquid chromatography-tandem mass spectrometry using a modification of the isotope dilution calibration method of Olsson and colleagues.[58] For the analysis of APE, METH, ETU, and PTU, they lyophilized, extracted and concentrated each sample. They analyzed the extracts using HPLC-MS/MS with isotope dilution calibration according to the method of

Montesano et al.[59] Limits of quantification were 0.5 μg/L for 2012 and 0.2 μg/L for 2013 for TCPY; 50 μg/L MDA for 2012 and 2013; 0.3 μg/L for APE and METH for 2012 and 2013; 0.2 μg/L for ETU and PTU for 2012 and 2013; 0.5 μg/L for 2012 and 0.4 μg/L for 2013 for 3PBA; 5 μg/L for 2012 and 0.3 μg/L for 2013 for DCCA. Because of analytical complications, they could not fully quantify MDA, and we report it as detected or not detected.

Measures

Participants are in the categories farmworker versus non-farmworker. Participant personal characteristics used to describe the sample include age, in the categories less than 30 years, 30 to 34 years, 35 to 44 years, and 45 years and older; education, in the categories 0 to 6 years, 7 to 11 years, 12 or more years; marital status, in the categories married or living as married versus not currently married; Mexico is their country of origin; and Spanish is their dominant language. Detection of a metabolite is defined as a concentration greater than or equal to the limit of quantification (LOQ). Concentrations for each pesticide urinary metabolite are reported as μg/L; the concentrations are not adjusted for creatinine as the creatinine levels differed little between the Latina farmworkers (2012 median concentration 95.0 μg/L; 2013 median concentration 187.4 μg/L) and non-farmworkers (2012 median concentration 131.0 μg/L; 2013 median concentration 176.3.4 μg/L). Median, 25th percentile, 75th percentile, 90th percentile, and maximum concentrations are reported.

Statistical Analysis

Participant characteristics were examined descriptively (count, percent) and Chi-square or Fisher's Exact tests were used to examine differences between farmworkers and non-farmworkers. For each pesticide urinary metabolite, the percentage of detections >LOQ were described within each year of data collection (2012, 2013) for farmworkers and non-farmworkers and Chi-Square and Fisher's Exact tests were again used to test for significant differences between the farmworker groups. Next, within each year, for each urinary metabolite with detections > LOQ the distribution of the concentrations were described using the median, 25th, 75th, and 90th percentiles, as well as the maximum value. The differences in concentration levels for farmworkers and non-farmworkers were tested using the non-parametric Wilcoxon-Mann-Whitney test. Finally, for each participant (within each year) we counted the total number of detections within 3 metabolite groupings (OPs, bis-dithiocarbamates, pyrethroids) as well as across all 14 metabolites and then aggregately examined the percentage of participants falling into categories of detection counts (0, 1, 2, 3, 4, 5+ for OPs and Total; 0, 1 for bis-dithiocarbamates; 0, 1–2 for pyrethroids). Chi-square or Fisher's Exact tests were used to examine farmworker/non-farmworker differences in the total number of detections. All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC) and p-values of less than 0.05 were considered statistically significant.

Results

Participants

The Latina farmworkers and non-farmworkers did not differ significantly in age; about one-third were less than 30 years old, with 19.4% of farmworkers and 9.1% of non-farmworkers being 45 years or older (Table 1). The farmworkers had less education than the non-farmworkers; 58.1% of the farmworkers and 32.7% of the non-farmworkers had 6 or fewer years of education. Most members of both groups were married. Mexico was the country of birth for 87.1% of the farmworkers and 72.7% of the non-farmworkers. Spanish was the dominant language of most participants.

Organophosphate Pesticide Urinary Metabolites

A high percentage of Latina farmworkers and non-farmworkers had detections for several DAPs in 2012 and 2013, and these groups differed little in the percentage of detections of the DAP metabolites in either year (Table 2). For 2012, over one-quarter of farmworkers and non-farmworkers had detections for DMP, DEP, and DETP; 61.3% of farmworkers and 81.8% of non-farmworkers had detections for DMTP. For 2013, over one-third of farmworkers and non-farmworkers had detections for DMP, about 60% of both groups had detections for DMTP, and almost all of both groups had detections for DEP and DETP.

A similar percentage of Latina farmworkers and non-farmworkers had detections for TCPY in 2012 and 2013, with a larger percent having detections in 2013 compared to 2012. Farmworkers had a greater percent of MDA detections than did non-farmworkers in 2012. A similar percentage of farmworkers and non-farmworkers had detections for APE and METH in both years. The percentage of detections for MDA, APE, and METH was lower in 2013 compared to 2012.

Concentrations of the OP urinary metabolites were similar for Latina farmworkers and non-farmworkers (Table 3). For 2012, the median concentrations of DMP were 10.7 μg/L among Latina farmworkers and 7.8 μg/L among Latina non-farmworkers, with the median concentrations of DEP being 4.9 μg/L for both farmworkers and non-farmworkers. Concentrations for each pesticide urinary metabolite were lower in 2013 compared to 2012. Latina non-farmworkers had significantly larger concentrations for DMTP and DETP for 2013 than did the Latina farmworkers.

Bis-dithiocarbamates

Over 15% of farmworkers and non-farmworkers had detections of ETU in 2012, with 1 non-farmworker having a detection of ETU in 2013 (Table 4). No participant had a detection for PTU in either year. Concentrations of these metabolites were similar for Latina farmworkers and non-farmworkers (Table 5).

Pyrethroids

For 2012, 74.2% of farmworkers and 60.0% of non-farmworkers had detections for 3PBA; for 2013, about 90% of both groups had detections for 3PBA. Very few participants had detections for DCCA for either year. Concentrations of these metabolites were similar for Latina farmworkers and non-farmworkers.

Number of Pesticide Urinary Metabolite Detections

Across 2012 and 2013, almost all Latina farmworkers and non-farmworkers had detections for at least one OP pesticide urinary metabolite (Table 6). Although fewer had detections for a bis-dithiocarbamates urinary metabolite, most had detections for at least one pyrethroid pesticide urinary metabolite. When we combine detections across all of the pesticide urinary metabolites, all of the participants had at least one detection, and most had two or more detections. For 2012, about 30% of all participants had 5 or more detections, and for 2013, 66.7% of Latina farmworkers and 57.1% of Latina non-farmworkers had 5 or more pesticide urinary metabolite detections.

Discussion

Detections for several pesticide urinary metabolites, including those for OP and pyrethroid insecticides, were present for substantial proportions of the Latina farmworkers and non-farmworkers who participated in this study. Concentrations for several of these metabolites were high. Latina farmworkers and non-farmworkers were similar in detections and concentrations for the pesticide urinary metabolites included in this analysis. Although Latina non-farmworkers had significantly larger concentrations for DMTP and DETP for 2013 than did the Latina farmworkers, caution should be taken in interpreting these differences due to the small number with detections in 2013 (particularly for DMTP) and the borderline p-values.

The Latina farmworkers and non-farmworkers in this study had greater concentrations for most of the OP urinary metabolites in 2012 than were reported for women and Mexican Americans who participated in the National Health and Nutrition Examination Survey (NHANES) for any year for which data are reported;[60] these include DMP, DMDTP, DEP, DETP, APE and METH. For example, the 75th percentile concentration for DMP among Latina farmworkers in our sample was 13.2 μg/L and among non-farmworkers was 18.0 μg/L, while that reported for all women in the 2007–08 NHANES was 7.91 μg/L and that reported for all Mexican-Americans was 7.46 μg/L. The 75th percentile concentration for ACE among Latina farmworkers in our sample was 1.5 μg/L and among non-farmworkers was 1.6 μg/L, while that reported for all women in the 2007–08 NHANES was below the limit of detection (LOD) and that reported for all Mexican-Americans was also below the LOD. For 2013, the Latinas in this study had greater concentrations of DETP than NHANES participants, but not of the other OP urinary metabolites. Participants in this study were similar to Florida farmworker and non-farmworker women in the overall high percentages of DAP pesticide urinary metabolite detections.[41] Concentrations were lower among the North Carolina women compared to the Florida women.

The women in this study in 2012 had greater concentrations of ETU than were reported for women and Mexican Americans in NHANES.[60] The 75th percentile concentration for ETU among Latina farmworkers in our sample was 3.7 μg/L and among non-farmworkers was 3.9 μg/L, while that reported for all women in the 2007–08 NHANES was below the LOD and that reported for all Mexican-Americans was also below the LOD. The women in this study in 2012 and 2013 had greater concentrations of 3PBA than were reported for women and Mexican Americans in NHANES.[60] The 75th percentile concentration for 3PBA among farmworkers was 3.1 μg/L in 2012 and 3.0 in 2013, and among non-farmworkers it was 3.6 μg/L in 2012 and 1.9 in 2013; while that reported for all women in the 2007–08 NHANES was 1.06 μg/L and that reported for all Mexican-Americans was 1.06 μg/L. 3PBA detections and concentrations for the women in this study were greater than those reported for Latinas participating in the CHAMACOS study (living in a California agricultural community in 1999–2001).[12] 3PBA detections for the women in this study were about the same as, or greater than those reported for Latinas participating in the MICASA study (living in a California agricultural community in 2009), with greater concentrations in 2012, but somewhat lower concentrations in 2013.[17] 3PBA detections and concentrations for the women in this study were greater than those reported for non-Latinas participating in the SUPERB study (non-agricultural, non-Hispanic white women living in northern California in 2009).[61]

The percentage of Latina farmworkers and non-farmworkers in this analysis with pesticide urinary metabolite detections and the concentrations of these metabolites are similar to those reported for male farmworkers and non-farmworkers in companion analyses.[4,5] Like this study, there were limited differences in detections and concentrations between male farmworkers and non-farmworkers in the companion analyses. Also like the results for male farmworkers and non-farmworkers in companion analyses, [4,5] detections and concentrations for each pesticide urinary metabolite differed between 2012 and 2013. This reflects the variations in individual exposures across time, and the effect of the time since exposure (speed with which the pesticides are metabolized and the metabolites excreted) on the presence and levels of metabolites that can be detected in biological samples.

Why This Is Important

Women in this study have similarly high or higher levels of detection and concentrations for pesticide urinary metabolites than do other US Latinas. These levels are greater than those for women in the general US population as reported in NHANES.[60] Most of the women in this study are of child-bearing age. The exposure to pesticides among Latinas is a health disparity. The health effects of this exposure may exacerbate other health disparities in this and other vulnerable populations.

Pesticide exposure among these women is important for their health and the health of their children. The pesticides included in this analysis are neurotoxins that can have immediate and long-term effects on human health.[24] The health effects of OP exposure for women include increased risk for cancer,[62,63] cognitive decline, [64–66] and respiratory disease.[67,68] Subclinical effects of OP exposure include cholinesterase depression [26,270] and impaired olfaction.[28] Their children have an increased risk for adverse neurocognitive development due to prenatal and postnatal pesticide exposure. [29–39] A growing body of literature indicates that pyrethroid insecticides can increase risk for health problems, [69,70] although these findings remain controversial.[71]

What Should Be Done

Research and policy need to consider pesticide exposure across vulnerable populations. This research needs to address pesticide exposure pathways of everyone, but particularly in vulnerable populations. The immediate and long-term health and developmental effects of exposure to low and high doses of pesticides need to be documented.

Policy is needed to reduce pesticide exposure in residential as well as occupational settings. Current policy addressing pesticide exposure is limited. Although OP insecticides are no longer available for residential use, the carbamate carbaryl (e.g., Sevin™) remains widely available. Pyrethroid insecticides are also widely available as the replacements for OP insecticides. The major pesticide safety regulation in agriculture is the US-Environmental Protection Agency Worker Protection Standard (WPS) (https://www.epa.gov/pesticide-worker-safety/agricultural-worker-protection-standard-wps). The WPS was recently revised (after a two decade discussion), but the implementation of this revision has been delayed. The recently revised WPS, like its predecessor, leans heavily on training workers but does little to affect the factors that influence workplace exposure (it does not require changes in the organization of work), and it includes no provision for the evaluation of its effectiveness at any level (documenting whether workers actually are trained, biomonitoring workers to see if any training is effective, biomonitoring family members to see if training is effective).

Limitations

This analysis should be evaluated in light of its limitations. The number of women included in this analysis is small and they were recruited from locations in a single state. The women were not randomly selected. Significant attrition of participants occurred during the two years of the study. These factors limit generalizations. The pesticide urinary metabolites included in the analysis are limited to insecticides and fungicides and represent a small number of the many pesticides and pesticide classes to which the women could be exposed. The current state of laboratory procedures limits the determination of pesticide detections and concentrations.

Conclusions

Latinas, regardless of their participation in farm work, are exposed to pesticides at higher rates and with greater concentrations of doses than the general US population. This pesticide exposure increases health risks for these women and their children. Research is needed to document pesticide exposure and its health effects in vulnerable populations and to evaluate means of reducing this exposure. Current information justifies the development of policy to reduce pesticide exposure in Latino agricultural and non-agricultural communities, as well as in all US communities.

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Table 1

Baseline Participant Characteristics of Latina Farmworkers and Non-Farmworkers, PEARL Project, 2012.

Participant Characteristics	Farmworkers n=31		Non-farmworkers n=55		p-value*
	n	%	n	%	
Age					0.1459
< 30 years	10	32.3	16	29.1	
30 to 34 years	8	25.8	9	16.4	
35 to 44 years	7	22.6	25	45.5	
45 years and older	6	19.4	5	9.1	
Education					0.0501
0 to 6 years	18	58.1	18	32.7	
7 to 11 years	9	29.0	20	36.4	
12 or more years	4	12.9	17	30.9	
Married or living as married	26	83.9	42	76.4	0.4113
Mexico – Country of Birth	27	87.1	40	72.7	0.1230
Spanish – Dominant Language	30	96.8	50	90.9	0.4119

* Chi-square or Fisher's Exact Test as appropriate

Table 2

Organophosphate Pesticide Urinary Metabolite Detections for Latina Farmworkers and Non-Farmworkers, 2012 and 2013.

Pesticide Urinary Metabolites	Farmworkers >LOQ n	Farmworkers >LOQ %	Non-farmworkers >LOQ n	Non-farmworkers >LOQ %	p-value*
2012	**N=31**		**N=55**		
Dialkylphosphates					
DMP	10	32.3	27	49.1	0.13
DMTP	19	61.3	45	81.8	0.03
DMDTP	3	9.7	12	21.8	0.15
DEP	9	29.0	15	27.3	0.86
DETP	8	25.8	21	38.2	0.24
DEDTP	0	0.0	0	0.0	--
Specific Organophosphates					
TCPY	8	25.8	14	25.5	0.97
MDA	11	35.5	9	16.4	0.04
APE	4	12.9	5	9.1	0.71
METH	4	12.9	3	5.5	0.24
2013	N=12		N=28		
Dialkylphosphates					
DMP	4	33.3	13	46.4	0.44
DMTP	7	58.3	17	60.7	1.00
DMDTP	0	0.0	0	0.0	--

Pesticide Urinary Metabolites	Detections				p-value*
	Farmworkers		Non-farmworkers		
	>LOQ		>LOQ		
	n	%	n	%	
	2012				
	N=31		N=55		
DEP	12	100.0	27	96.4	--
DETP	12	100.0	27	96.4	--
DEDTP	0	0.0	0	0.0	--
Specific Organophosphates					
TCPY	11	91.7	27	96.4	0.51
MDA	1	8.3	2	7.1	--
APE	0	0.0	0	0.0	--
METH	0	0.0	0	0.0	--

* Chi-square or Fisher's Exact Test as appropriate

Table 3

Organophosphate Pesticide Urinary Metabolite Concentrations (μg/L) for Values above the Limit of Quantification (>LOQ) for Latina Farmworkers and Non-Farmworkers, 2012 and 2013.

Pesticide Urinary Metabolites	Concentrations (μg/L)												p-value†
	Farmworkers						Non-farmworkers						
	>LOQ	Median	Percentiles 25th	75th	90th	Maximum	>LOQ	Median	Percentiles 25th	75th	90th	Maximum	
	2012												
	N=31						**N=55**						
Dialkylphosphates													
DMP	10	10.7	5.9	13.2	18.9	20.0	27	7.8	3.7	18.0	27.8	37.7	0.62
DMTP	19	2.6	1.5	8.2	29.8	37.9	45	2.8	1.6	6.2	17.5	40.4	1.00
DMDTP	3	2.4	0.6	25.0	25.0	25.0	12	2.7	1.8	4.0	6.6	6.8	1.00
DEP	9	4.9	1.9	7.6	14.3	14.3	15	4.9	1.7	7.5	9.6	12.7	0.63
DETP	8	1.5	1.2	3.2	3.3	3.3	21	1.2	0.7	2.5	3.2	6.2	0.34
DEDTP	0	--	--	--	--	--	0	--	--	--	--	--	--
Specific Organophosphates													
TCPY	8	2.7	1.7	7.8	14.3	14.3	14	4.4	2.0	7.4	9.7	10.3	0.66
APE	4	0.9	0.8	1.5	2.1	2.1	5	0.7	0.6	1.6	1.8	1.8	0.39
METH	4	0.6	0.4	0.8	1.0	1.0	3	0.9	0.9	0.9	0.9	0.9	1.00
	2013												
	N=12						N=28						
Dialkylphosphates													
DMP	4	0.6	0.4	0.8	0.8	0.8	13	0.8	0.7	0.9	1.1	1.1	0.28
DMTP	7	0.9	0.3	1.2	1.5	1.5	17	1.4	0.7	2.0	3.1	4.1	0.03
DMDTP	0	--	--	--	--	--	0	--	--	--	--	--	--
DEP	12	2.7	1.5	4.2	5.5	9.2	27	3.8	2.0	10.8	12.2	17.9	0.12
DETP	12	0.8	0.4	2.1	2.2	4.4	27	2.6	0.6	4.6	9.8	12.2	0.04

Pesticide Urinary Metabolites	Concentrations (µg/L)												p-value†
	Farmworkers						Non-farmworkers						
	>LOQ	Median	Percentiles 25th	75th	90th	Maximum	>LOQ	Median	Percentiles 25th	75th	90th	Maximum	
	2012												
	N=31						N=55						
DEDTP	0	--	--	--	--	--	0	--	--	--	--	--	--
Specific Organophosphates													
TCPY	11	2.0	0.9	2.6	3.2	4.2	27	2.6	1.3	3.7	4.2	4.3	0.13
APE	0	--	--	--	--	--	0	--	--	--	--	--	--
METH	0	--	--	--	--	--	0	--	--	--	--	--	--

† non-parametric test

Table 4

Bis-dithiocarbamate and Pyrethroid Pesticide Urinary Metabolite Detections for Latina Farmworkers and Non-Farmworkers, 2012 and 2013.

Pesticide Urinary Metabolites	Detections				p-value*
	Farmworkers		Non-farmworkers		
	>LOQ		>LOQ		
	n	%	n	%	
	2012				
	N=31		N=55		
Bis-dithiocarbamates					
ETU	6	19.4	9	16.4	0.72
PTU	0	0.0	0	0.0	--
Pyrethroids					
3PBA	23	74.2	33	60.0	0.18
DCCA	1	3.2	1	1.8	--
	2013				
	N=12		N=28		
Bis-dithiocarbamates					
ETU	0	0.0	1	3.6	--
PTU	0	0.0	0	0.0	--
Pyrethroids					
3PBA	11	91.7	25	89.3	1.00
DCCA	0	0.0	0	0.0	--

* Chi-square or Fisher's Exact Test as appropriate

Table 5

Bis-dithiocarbamate and Pyrethroid Pesticide Urinary Metabolite Concentrations (μg/L) for Values above the Limit of Quantification (>LOQ) for Latina Farmworkers and Non-Farmworkers, 2012 and 2013.

Pesticide Urinary Metabolites	Concentrations (μg/L)												p-value[†]
	Farmworkers						Non-farmworkers						
	>LOQ	Median	Percentiles 25th	Percentiles 75th	Percentiles 90th	Maximum	>LOQ	Median	Percentiles 25th	Percentiles 75th	Percentiles 90th	Maximum	
	2012												
	N=31						**N=55**						
Bis-dithiocarbamates													
ETU	6	1.4	0.8	3.7	16.2	16.2	9	1.4	0.7	3.9	8.4	8.4	1.00
PTU	0	--	--	--	--	--	0	--	--	--	--	--	--
Pyrethroids													
3PBA	23	2.4	1.2	3.1	3.9	23.2	33	2.4	1.4	3.6	4.1	32.0	0.78
DCCA	1	5.9	--	--	--	--	1	10.0	--	--	--	--	--
	2013												
	N=12						N=28						
Bis-dithiocarbamates													
ETU	0	--	--	--	--	--	1	0.9	--	--	--	--	--
PTU	0	--	--	--	--	--	0	--	--	--	--	--	--
Pyrethroids													
3PBA	11	1.0	0.5	3.0	3.0	3.1	25	1.4	0.6	1.9	2.8	2.9	0.72
DCCA	0	--	--	--	--	--	0	--	--	--	--	--	--

[†] non-parametric test

Table 6

Total Number of Organophosphate, Bis-dithiocarbamate and Pyrethroid Pesticide Urinary Metabolite Detections for Latina Farmworkers and Non-Farmworkers, 2012 and 2013.

Pesticide Urinary Metabolites	Number of Detections				p-value*
	Farmworkers		Non-farmworkers		
	n	%	n	%	
	2012				
	N=31		N=55		
Number of OP Pesticide Urinary Metabolite Detections (6 DAPs, TCPY, MDA, APE, METH)					0.3067
0	3	9.7	4	7.3	
1	12	38.7	11	20.0	
2	3	9.7	13	23.6	
3	3	9.7	10	18.2	
4	3	9.7	7	12.7	
5 or more	7	22.6	10	18.2	
Number of Bis-dithiocarbamates Urinary Metabolite Detections					0.7256
0	25	80.7	46	83.6	
1	6	19.3	9	16.4	
Pyrethroids Urinary Metabolite Detections					0.1848
0	8	25.8	22	40.0	
1–2	23	74.2	33	60.0	
Total Number of All Pesticide Urinary Metabolite Detections					0.3590
0	0	0	0	0	
1	2	6.5	6	10.9	
2	12	38.7	12	21.8	
3	5	16.1	12	21.8	
4	2	6.5	9	16.4	
5 or more	10	32.3	16	29.1	

2013

Pesticide Urinary Metabolites	Number of Detections				p-value*
	Farmworkers		Non-farmworkers		
	n	%	n	%	
	2012				
	N=31		N=55		
	N=12		N=28		
Number of OP Pesticide Urinary Metabolite Detections (6 DAPs, TCPY, MDA, APE, METH)					0.1544
0	0	0	0	0	
1	0	0	1	3.6	
2	0	0	0	0	
3	4	33.3	11	39.3	
4	5	41.7	3	10.7	
5 or more	3	25.0	13	46.4	
Number of Bis-dithiocarbamates Urinary Metabolite Detections					--
0	12	100	27	96.4	
1	0	0	1	3.6	
Pyrethroids Urinary Metabolite Detections					1.000
0	1	8.3	3	10.7	
1	11	91.7	25	89.3	
Total Number of All Pesticide Urinary Metabolite Detections					0.9080
0	0	0	0	0	
1	0	0	0	0	
2	0	0	1	3.6	
3	1	8.3	2	7.1	
4	3	25.0	9	32.1	
5 or more	8	66.7	16	57.1	

*Chi-Sq or Fisher's Exact