A Feasibility Study of the Use of Dust Wipe Samples to Assess Pesticide Exposures in Migrant Farmworker Families

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ABSTRACT. While documentation of pesticide exposure among agricultural workers is increasing, similar data describing exposure in migrant farmworkers is lacking. Exposure assessment in migrant farmworker populations is difficult since this population travels seasonally for employment in temporary work environments. The present feasibility study addressed these obstacles by teaching participants to obtain dust samples that could be used to measure pesticide exposure at the time of exposure during the migration season. Using floor dust wipes in their temporary housing, mothers were asked to collect and return via U.S. mail, one house dust sample per week for four weeks. Of 10 mothers invited to participate in 2003, seven mothers submitted a total of 27 samples. Samples underwent chemical analysis for organophosphate and triazine pesticides. One or more pesticides were present in dust extracts at concentrations above the detection limit in 24 samples.

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INTRODUCTION

Since agricultural labor demands vary by crop and season in the United States, migrant farmworkers help to meet current labor needs. This largely foreign-born workforce[1] travels across the United States for employment in a variety of agricultural jobs on a seasonal basis. These workers find employment in field agriculture, nurseries, greenhouses, and food processing.[2] Migrant farmworkers labor several days per week for long hours, yet few have access to health insurance and the median annual family income is less than $17,500.[3] Estimates of the national population range from 1-4 million,[4] but enumeration is complicated by the lack of a universal definition of "migrant" and "seasonal" work status.[5] Larson calculated a more precise estimate of 2,038,210 migrant and seasonal farmworkers in 10 states including Arkansas, California, Florida, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, Texas, and Washington.[2] Many of these farmworkers are children or have children living with them. Of parents who participated in the 2000-2001 National Agricultural Workers Survey (NAWS), 61 percent were living with their minor children at the time of interview. In addition, 6 percent of all participants were 14-17 years old.[3]

For this working population, agricultural pesticide exposure is a major occupational health hazard.[6] Although the literature is growing, little is known about the dose or duration of pesticide exposure and health effects in migrant farmworkers or their children. Pesticides describes a variety of agents including insecticides, herbicides, fungicides, and rodenticides.[7] Organophosphates and triazines are common agricultural pesticides utilized in the United States. As a family, organophosphate pesticides are of particular concern due to their widespread agricultural use and potential neurotoxicity. Organophosphates inhibit the neurotransmitter, acetylcholinesterase, resulting in a toxic, cholinergic excess affecting the nervous system.[7] Acute organophosphate exposure in high doses has been related to lasting neurobehavioral effects such as difficulty with or reduction in memory, attention, academic skills, abstraction, and motor skills in agricultural workers.[8-9] The potential effects of chronic low dose exposure are not entirely known but may include changes in mood and affect, reduction in neurobehavioral performance, and different types of cancer.[10] Atrazine and simazine are herbicides belonging to the triazine family. Their mechanism of action involves inhibition of plant photosynthesis.[7] Animal studies conducted with rats suggest that atrazine can act as an endocrine disruptor with potential consequences including reproductive developmental effects and mammary gland tumor formation.[11-14] Studies examining atrazine and simazine and the occurrence of various cancers in humans report mixed results.[15-18]

In addition to exposure at work, other exposure pathways for farmworkers and their families are "household proximity" and "take home" pathways.[19] These additional pathways may be associated with chronic low level exposures. As noted above in reference to organophosphates, the effect of acute high levels of pesticide is known, the effect of chronic low level exposure is a major gap in the literature for farmworkers as well as other populations. Housing in close proximity to agricultural fields could be exposed regularly to pesticide drift following aerial spraying. Farmworkers also may unintentionally bring home pesticide residues on their work clothes and shoes. Because of differences in size, metabolism, and rapid growth, farmworker youth and their siblings may have an enhanced susceptibility compared to adults.[20] Given these exposure routes and the potential for children and other family members to be exposed, exposure to pesticide residues in the home has been increasingly the focus of agricultural research. A variety of methods are available for conducting both biologic (e.g., blood, urine) and environmental (e.g, air, house dust) monitoring of farmworkers and residents in agricultural regions. These methods and their strengths and limitations are well described by Hoppin et al.[22] and Barr et al.[23] In studies involving children, environmental may be preferred to biologic sampling since these methods are frequently less invasive and more acceptable to participants. However, environmental monitoring such as dust sampling should be considered a marker of pesticide exposure and not a surrogate for personal exposure methods such as monitoring metabolites in individuals.[21]

Many studies have targeted and successfully measured organophosphate and triazine levels in house dust. Common dust sampling methods include vacuum sampling, and surface and hand wipes.[19,23-27] Both methods have been used in studies that describe elevated levels of organophosphate pesticides in agricultural families. Compared to non-agricultural reference homes, Simcox et al.[23] used a vacuum sampler and found significantly elevated levels of organophosphate pesticides (azinphosmethyl, $p = 0.0001$; chlorpyrifos, $p = 0.01$; parathion, $p = 0.07$) in house dust of agricultural homes and reported that proximity to farmland was associated with increased organophosphate pesticide levels in house dust. Similarly, Lu et al.[19] reported that compared to non-agricultural families, house dust sampled using floor wipes from agricultural families had 6.7, 1.6, and 7.1 times the amount of azinphos methyl, phosmet, and dimethyl organophosphate, respectively. In an unprecedented study of Hispanic agricultural workers in Oregon, Rothlein et al.[28] examined the correlation between vacuum sampled house dust, urinary organophosphate metabolites, and neurobehavioral performance in order to address the issue of chronic low-level exposure. Overall, the neurobehavioral performance of agricultural workers was lower compared to a comparison group of non-agricultural workers. In addition, among the farmworkers, increasing urinary metabolite levels was associated with lower neurobehavioral performance and was correlated with house dust concentration ($r_s = 0.47$, one-sided $p = 0.013$).

Assessing exposure in a similar manner in house dust among migrant farmworker populations is hindered partially due to their mobility. While monitoring pesticide exposure at a single location (e.g., migrant camps or home base locations) is feasible with this population, collection of samples while farmworkers travel for employment at multiple sites across the United States is complicated if not impossible. Furthermore, biologic assessments conducted at the farmworkers' home bases at the end of the migration season may not detect metabolites due to the short half-lives of many pesticides. Methods of exposure assessment need to be developed that are tailored to this uniquely mobile population composed of adults and children, and that allow for exposure assessment proximate in time to the exposure. Teaching participants to collect their own samples at the time of exposure is one way to address this issue. High travel costs, personnel time, and other issues prompted protocols that involved asking participants collect their own samples.[29] This approach has facilitated epidemiologic research in the areas of nutrition (e.g., food diaries) and fertility (e.g., semen samples).[30,31] Environmental studies are beginning to incorporate similar participant-collected sampling protocols. Thorne et al.[29] completed a pilot study developing a method whereby participants would sample their residence for endotoxins using electrostatic wiping cloths. Arbes et al.[32] utilized participants in the sampling process of their study looking at indoor allergens. Via mail, participants received a dust collection package containing various materials, including a commercially available vacuum attachment that can be used for dust sampling and supplies for return shipping. To evaluate this method of self-collection, study staff also collected a sample, using a gold standard cellulose extraction thimble, from a similar area in each participant's home on the same day. With respect to allergen concentration, participant-collected samples correlated well with staff-collected samples ($r \geq 0.87$). However, participants collected samples that weighed less than those collected by staff. Discrepancies could be related to differences in vacuum cleaner characteristics (e.g., efficiency, age), use of the different sampling attachments for staff, and possible lost sample as staff samples were not mailed. The authors concluded that participant collected sampling was a valid and practical method for epidemiologic studies that utilized allergen concentration as the exposure of interest. Fenske et al.[33] recently described a methodology currently under investigation wherein participants would use alcohol wipes to sample the top of door frames for pesticides in house dust and return sample via mail. Finally, researchers have asked participants to submit their used vacuum cleaner bags for analysis.[34] Along with the benefits of participant-collected samples, in terms of cost savings and increased flexibility of study design, many limitations apply to wipe as well as vacuum sampling. These include: (1) potentially lower sample return rates; (2) sampling variability between participants may be high; (3) participants may not have access to required equipment (e.g., vacuum cleaners); (4) participants may not be physical able to take samples; (5) participants may need to be able to read and follow written directions; and (6) a certain quantity of dust may be required to complete desired analyses.[32,33] Although these limitations need to be acknowledged and addressed, participant-collected samples could be one method for use with mobile populations, especially dust wipes due to their low cost and ease of use. To describe the feasibility of involving migrant farmworkers in the data collection process, this pilot study focused on teaching migrant farmworker mothers how to collect wipe samples while working an agricultural job away from their usual residences in Alto Bonito, TX. Specifically, mothers were asked to sample a hard floor area closest to the front door of their temporary housing for pesticide exposure using dust wipes once a week for four weeks. The results and methods described in this paper have implications for research in other mobile populations or other research scenarios, such as those described above, that require multiple samples.

METHODS

The design of this study involved prospectively following a small cohort of migrant farmworker mothers during the 2003 migration season. Each year from approximately May to October, the mothers and their families migrate away from their usual residences in Alto Bonito, TX, to do farm work in various locations across the United States. Alto Bonito is a small city located along the Texas-Mexico border in Starr County, TX, a region with an estimated 5,045 migrant and seasonal farmworkers.[2] Similar to Starr County as a whole, the residents of Alto Bonito are almost entirely Hispanic and economically disadvantaged.[35] This protocol was reviewed and approved by The Committee for the Protection of Human Subjects at The University of Texas Health Science Center at Houston and the Institutional Review Board at Texas A&M University.

Because the focus of this project was to assess the feasibility of collecting pesticide exposure data during the migration season and not estimating associations between exposures and outcomes, sample size and power calculations were not computed. The sample size is necessarily small until the concepts of this study are demonstrated and the investment of more substantial resources is justified. Consequently, a convenience sample of participants from a prior study titled, "A Study of Work Injuries in Farmworker Children," (1 U50 OH07541) was selected. During the earlier study, permission to approach participating mothers regarding future research projects was obtained. Fifteen mothers were recruited for the present feasibility study. However 10 mothers actually migrated in 2001 and were eligible to participate. In any given year, farmworker families may choose not to migrate for a variety of reasons including job availability and family events. Seven of the ten mothers collected and submitted at least one sample for a response rate of 70 percent. The three reasons for not participating included leaving the sampling kit in Starr County, loss of the sampling kit to a car crash, and loss of the sampling kit while changing residences within Starr County.

Prior to migrating, mothers attended a training session during which each mother completed a pre-migration survey of demographic and contact information. The pre-migration survey was constructed in English and translated into Spanish and required approximately 10 minutes to complete. Items were taken from a prior study of acute injuries among migrant farmworker families.[36] Interviewers bilingual in Spanish and English administered the pre-migration survey. Participants also signed an informed consent document at this time. Two training sessions were conducted at two separate centralized locations in the community. The main training session was conducted at the La Grulla Elementary School Cafeteria in late May 2003. Conducting the training at a school conveyed the legitimacy of the project to participants since the principal had to approve our activities. This is an advantage when working with potentially undocumented populations. Four mothers unable to attend the first training session attended a second training session in early June 2003 that was conducted at a private residence in Alto Bonito. The training sessions included a brief introduction to the project, dispensation of the sampling kits, and a series of practice sampling exercises. After trainers demonstrated the desired procedure, mothers completed a series of practice samples to ensure uniformity in sampling technique within and between mothers as much as possible. Trainers assisted in practice sampling until each mother demonstrated mastery of the technique. Five trainers were present at the first training while three trainers were present at the second training. Although mothers were the study participants, other family members including spouses and children accompanied the mothers and expressed an interest in also joining the study. Training goals included teaching proper sampling techniques, emphasizing the importance of strict adherence to data collection protocols, and motivating mothers to become dedicated data collectors by inviting them to become a member of the research team.

Trainers issued each mother a sampling kit. Each sampling kit contained adequate supplies to collect and submit 4 samples (1 sample/week for 4 weeks) using a dust wipe. Each kit included: a measuring tape, polyethylene collection bags, isopropyl alcohol, aluminum foil, dust wipes (cotton fiber cloth heated in a muffle oven to remove residual organics), mailing labels, postage-paid shipping envelopes, reminder schedules, and copies of the sample survey. The sample survey documented where/when the samples were collected, approximate size of sampled location, and the participant's geographical location. The sample survey was constructed in English and translated into Spanish. Both languages appeared together on the sampling form. Items were adapted from a sampling form used in a prior study involving staff-collected dust wipe samples.[37] Each participant was asked to select an uncarpeted area of her temporary migrant housing that was closest to the front door. Similar to procedures described by Lu et al.[19] and Shalat et al.,[37] dust was collected from approximately 36 square inches of uncarpeted floor. A wipe was saturated with isopropyl alcohol and used to wipe the sampling area using a series of vertical and horizontal strokes. The sample was wrapped in aluminum foil, placed into a polyethylene collection bag, and sealed in a postage-paid shipping container. Mothers were asked to mail each sample immediately after collection. If possible, mothers were asked to store samples in a freezer or cool area until the sample could be mailed. Mothers were asked to mail samples via U.S. Postal Service to the principal investigator at Texas A&M University System Health Science Center School of Rural Public Health. Once received, samples were stored in a freezer until analysis.

Mothers were interviewed a second time after their return to Alto Bonito from October 2003 through January 2004. At this time, a bilingual interviewer administered a post-migration survey constructed in English and translated into Spanish. The survey consisted of approximately 13 items adapted from the same prior survey as the pre-migration survey,[36] and that asked each participant to describe her employment during the migration season and her experience using the dust wipes. Each participant received $10 compensation in the form of a gift card from a large retail establishment for each wipe sample (maximum of $40 for 4 samples) that was returned via U.S. Postal Service. Compensation was dispensed during the follow-up interview.

Chemical Analyses

Analysis of samples was through TDI-Brooks International, College Station, TX. Similar to methods described by Shalat et al.,[37] an automated extraction apparatus, Dionex ASE 200 Accelerated Solvent Extractor (Dionex Corp., Sunnyvale, CA) was used to extracted various organic analytes from the dust wipe samples. Triphenyl Phosphate, a surrogate compound for organophosphate pesticides, was added to the samples prior to extraction and is used to assess the extraction and concentration efficiency of the procedure. The surrogate compound is resolved from, but elutes in close proximity to, the analytes of interest. The extractions are performed with dichloromethane:acetone 50:50 inside stainless-steel extraction cells held at elevated temperature (100°C) and solvent pressure (2,000 PSI). The analytes dissolved in the solvent are transferred from the heated extraction cells to a 60-mL glass collection vial. Extracts are then concentrated to a final volume of 1-mL (hexane:acetone 50:50) using an evaporative solvent reduction apparatus (Zymark TurboVap II, Zymark Corp, Hopkinton, MA).

The laboratory analyzed the dust wipe samples for the following organophosphate compounds: azinphos-methyl, demeton O, demeton S, diazinon, disulfoton, ethion, fonofos, fenithrothion, malathion, parathion ethyl, and parathion-methyl and chlopyrifos (a chlorinated organophosphate). Although not organophosphates, atrazine and simazine (triazines) are also detectable with the methods used, and were also analyzed. Organophosphate pesticides are quantified using a HP5890 gas chromatograph (Hewlett-Packard, Palo Alto, CA) with a nitrogen phosphorous detector (GC/NPD). The internal standard solutions tetrachloro-m-xylene (TCMX) and 1-bromo-2-nitrobenzene are added to sample extracts prior to instrument analysis for the determination of organophosphate pesticides. The GC-NPD is temperature-programmed and operated in the split mode with a DB-5 (30 m $\times$ 0.25 mm ID and 0.25 μm film thickness (J&W Scientific, Folsom, CA). Carrier flow is by conventional pressure control. The autosampler is capable of making 1 to 5 μL injections. Single high-resolution capillary column and NPD is used. The data acquisition system is by HP Chemstation software, capable of acquiring and processing GC data. Instruments were calibrated using commercial standards.

Statistical Analysis

Given the pilot nature of this study and the small sample size, the analysis was descriptive and the overall evaluation qualitative.

RESULTS

Pre-Migration Survey

The mothers ranged in age from 32 to 46 years. The mean and median ages were both 41 years. Six of the mothers were born in Mexico while one mother was born in the United States. Mothers lived in the Alto Bonito area from 4 to 41 years with average of 15 years and a median of 11 years. Mothers had 4 to 12 years of education with an average of 7.9 years and a median of 6 years. Six mothers participated in farm work in the last 12 months while one mother did not.

Chemical Analysis and Sampling Form

In total, six mothers submitted four samples while one mother submitted three samples for a total of 27 samples. Each returned sample included the dust wipe and the accompanying sampling form. All submitted samples were analyzed.

Of the 27 samples, 25 sampling forms had no errors or were missing data that was not necessary to complete analysis (e.g., date of sample missing on form, but date was included on the sample itself). Two sampling forms were missing a key piece of data such as the dimensions of the sampled area. Literacy was an issue with one mom but her family helped her complete the sampling form. One mother collected all four samples in one day from four different areas in her home. The most frequently sampled rooms were kitchens (19) followed by bathrooms (3), next to front door (3), bedrooms (1), and living rooms (1). One mother took the four samples from four different rooms rather than the area nearest to the front door with hard flooring. Sixteen samples were stored in freezers by participants prior to mailing and 22 samples were mailed immediately after collection. Because mothers indicated that many samples were both mailed immediately and stored in a freezer following sampling, there may have been an error with completing those items on the sampling form.

The recovery of the surrogate, triphenyl phosphate, varied within the samples from between 78 percent and 106 percent. The reported concentrations are surrogate corrected. Demeton

O & S and disulfoton had low recoveries. Therefore, observations regarding the presence or absence of these compounds are prohibited. Of the 27 samples, one sample was lost at extraction during analysis. Of the 26 remaining samples, pesticides were detected, but at concentrations that were below the MDL (minimum detectable limit) (0.50 μg/mL) in 24 samples (Table 1). Nine samples were found to have concentrations above MDL (0.50 μg/mL) of one or more organophosphate (i.e., chlorpyrifos, diazinon, fonofos, malathion) or triazine (i.e., atrazine, simazine) pesticides (Table 2). Levels above MDL were standardized by the area sampled. In order to compare levels with other research, concentrations were standardized to $\mu g/m^2$, ng/cm^2, and ng/m^2 (Table 2). Pesticides were not detected at any level in two of the samples.

Post-Migration Survey

Mothers worked in Illinois, Nebraska, Texas, and Wisconsin. Job tasks included hoeing beets, cotton, and watermelon, detasseling corn, and sorting green beans. Four mothers worked for farm owners while three mothers worked for contractors. On average, the mothers worked 9.3 hours per day (range: 6 to 12 hours) 6 days a week (range: 3 to 7 days). On average, mothers required 12.6 minutes to collect a sample (range: 5 to 20 minutes; median: 15 minutes).

When asked about their willingness to participate in a similar project in the future, all mothers gave a positive endorsement and found the protocols acceptable. When asked the number of samples they would be willing to collect per week, all mothers responded one sample per week during the migration season. Overall, mothers thought the sampling process was "easy enough." One mother suggested decreasing the length of the sampling form. When asked to describe what they liked about the project, mothers gave the following responses, "the (gift) cards," "learn about surroundings in which we work," "being part of the study," "liked helping if was used for their well-being," and "everything."

TABLE 1. Detected ranges of compounds from 26 samples.

Compound	Number of Samples < MDL	Number of Samples ≥ MDL	Range of Detected Concentrations[a] μg/ml
Organophosphates			
Azinphos-methyl	1	0	< MDL
Chlorpyrifos	17	2	< MDL-1.28
Demeton O[b]	0	0	0
Demeton S[b]	0	0	0
Diazinon	17	2	< MDL-0.73
Disulfoton‡	1	0	< MDL
Ethion	1	0	< MDL
Fenithrothion	1	0	< MDL
Fonofos	12	2	< MDL-1.62
Malathion	20	1	< MDL-0.59
Parathion, ethyl	0	0	< MDL
Parathion, methyl	6	0	< MDL
Triazines			
Atrazine	10	3	< MDL-1.14
Simazine	7	2	< MDL-0.88

No compounds detected in 2 samples
[a]Surrogate corrected values
[b]Low recovery

DISCUSSION

Overall, this project demonstrated that migrant farmworker mothers are interested and enthusiastic about participating in the sampling process. Mothers were willing to submit multiple samples on a scheduled basis over time and from different locations. As a result, a marker of pesticide exposure was assessed closer to the time of potential exposure and data collection was completed during the migration season while farmworkers were mobilized for work and largely inaccessible to the study staff. In general, mothers adhered to sampling protocols and the majority of sampling forms were complete and missing little or no data. It is suggested for future applications that participants be asked to provide key pieces of information in multiple fields on the sampling form or sample packaging. For example, mothers were asked to write the date of the sample on the sampling form as well as on the outside of the polyethylene bag containing the sample.

In this study, the concentration of detected pesticides was lower than other studies utilizing dust wipes from floor surfaces.[19,26,38] Lu et al.[19] conducted a study examining the presence

TABLE 2. Individual dust wipe samples with concentrations of compounds above the MDL and standardized to the area sampled.

Compound	Sample	Surrogate corrected concentration μg/ml	Standardized concentration μg/m^{2a}	Standardized concentration ng/m^{2a}	Standardized concentration ng/cm^{2a}
Organophosphates					
Chlorpyrifos	FWA	0.74	1.110	1,110	0.0010
Chlorpyrifos	FWB	1.28	1.530	1,530	0.0015
Diazinon	FWC	0.73	0.873	873	0.0009
Diazinon	FWB	0.56	0.670	670	0.0007
Fonofos	FWD	1.62	1.940	1,940	0.0019
Fonofos	FWE	0.54	N/C[b]	N/C[b]	N/C[b]
Malathion	FWF	0.59	0.689	689	0.0007
Triazines					
Atrazine	FWA	1.14	1.700	1,700	0.0017
Atrazine	FWG	0.65	0.777	777	0.0008
Atrazine	FWH	0.99	N/C[b]	N/C[b]	N/C[b]
Simazine	FWA	0.88	1.320	1,320	0.0013
Simazine	FWI	0.50	0.598	598	0.0006

[a]Surrogate corrected
[b]N/C: not calculable due to missing values

of azinphos-methyl and phosmet residues in agricultural versus non-agricultural households in Washington state. The 62 households designated as an "agricultural household" were within 200 feet of a treated orchard and/or at least one family member was employed as a farm worker/orchardist/applicator. Concentrations of azinphos-methyl and phosmet ranged from 0-0.02 μg/cm^2 with a mean and median of 0.002 and 0, respectively. In the current study, one sample had a concentration of azinphos-methyl below the MDL and phosmet was not examined. Quandt et al.[26] conducted a similar study in 41 farmworker homes in North Carolina and Virginia wherein exposure to agricultural and residential pesticide was measured on the surface of floors, toys, and child's hands from June to December of 2001. The concentration of simizine ranged from 1.2-70.0 μg/m^2 with a mean of 20.4 μg/m^2. This is higher than the present study wherein the concentrations ranged from < MDL to 1.320 μg/m^2. The concentrations of chlorpyrifos and diazinon were 0.2-87.9 μg/m^2 (mean: 8.9 μg/m^2) and 0.4-9.4 μg/m^2 (mean: 2.6 μg/m^2), respectively. Concentrations of the two compounds in the present study were lower overall with 1.530 μg/m^2 for chlorpyrifos and 0.873 μg/m^2 for diazinon. Finally, Morgan et al.[38] completed a study examining exposure to chlorpyrifos and its degradation product 3,5,6-trichloro-2-pyridinal (TCP) in preschoolers from North Carolina that were not described as members of agricultural families or living in agricultural residences. Samples were collected from hard floor surface wipes, indoor and outdoor air, soil, hand wipes, solid food, transferable residues, and food preparation surfaces wipes from July 2000 through March 2001. The mean concentration of chlorpyrifos on hard floor surfaces was 0.02 ng/cm^2, a level more similar to that found in the present study (< MDL-0.0015 ng/cm^2). Differing from the studies discussed above, lower concentrations were reported in one study of 27 homes located in a Texas colonia near the Texas-Mexico border.[27] This area is a rural community adjacent to agricultural fields. Of wipe samples collected during smiliar months as the present study (May to August), concentrations of some of the examined compounds, chlorpyrifos, fonofos, malathion, atrazine, and simazine, were greater in the present study.

Limitations of this study should be considered, especially in terms of subsequent or related applications. The lower concentrations found in this study may be related to some of these study limitations. Although participants were asked to store samples in a freezer prior to mailing, this study did not include any other method for minimizing degradation of samples prior to or during shipment. The compounds may have degraded due to exposure to heat during the summer months while the samples were en route via U.S. Postal Service to the principal investigator. Future studies would need to address this issue. Providing participants with gel refrigerant packs could be an option if participants have freezers and the quantity of gel refrigerant packs needed to maintain samples at a low temperature for the duration of shipment is not excessive. In addition, field quality control (QC) samples need to be included in future study designs to monitor potential degradation. Because sample collection was completed by various mothers, there may be variation in sampling technique that could introduce bias in a larger study of a specific exposure and outcome relationship. For example, compounds may have been present in the house dust, but mothers did not apply sufficient isopropyl alcohol or sufficient pressure to collect a complete sample. Consequently, it is imperative that researchers convey the importance of strict adherence to sampling protocols and the potential adverse effects of improper sampling on study findings. As implemented in this study, demonstration, repeated practice observed by trainers prior to migration, inviting participants to become a member of the research team, and educating participants about the research process are the main means investigators have to address this potential bias. Another limitation is sample return rates. Participants in a future study may not remember to collect samples, however response from this study indicates that mothers who responded participated completely. In the post-migration survey, mothers from this study suggested establishing some form of communication during the migration season to address this issue. Finally, the participants encompassed a small, convenience sample that could have resulted in selection bias and impacts the generalization of results.

Despite the limitations, this study demonstrated the ability of migrant farmworker mothers to collect samples by employing an innovative methodology designed to address the unique challenges of a mobile population. Methods presented in this feasibility study could help to improve assessment of work hazards and health effects among migrant farmworker adults and their children in larger research projects. The protocol, as well as our findings, may also have implications for research in other mobile populations and projects with limited funds or staff that would benefit from repeated sampling over time.

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