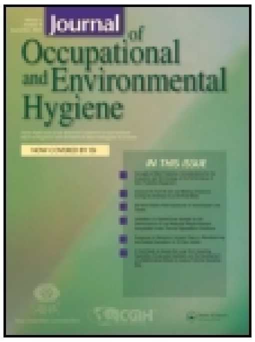

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Where's the Dust? Characterizing Locations of Azinphos-Methyl Residues in House and Vehicle Dust Among Farmworkers with Young Children

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Organophosphate pesticides are commonly used in the United States, and farmworkers are at risk for chronic exposure. Using data from a community randomized trial to interrupt the take-home pathway of pesticide exposure, we examined the association between floor surface type (smooth floor, thin carpet, and thick carpet) and rooms in which dust samples were collected (living room vs. non-living room) and concentrations of azinphos-methyl residues in home environments. We also examined the association between vehicle type (truck, auto, or other) and footwell floor surfaces (carpeted, smooth surface, or no mat) and concentrations of azinphos-methyl in vehicle dust samples. Dust samples were collected from 203 and 179 households and vehicles, respectively. All households had at least one child aged 2–6. Vehicle dust samples were collected from footwells of the vehicle used for commuting to and from work. A total of 183 samples were collected from living rooms, and 20 were collected from other rooms in the home. Forty-two samples were collected from thick carpets, 130 from thin carpets, and 27 from smooth floor surfaces. Thick and thin carpets had a significantly greater dust mass than smooth floor surfaces (6.0 g/m^2 for thick carpets, 7.8 g/m^2 for thin carpets, and 1.5 g/m^2 for smooth surfaces). Of the 179 vehicle samples, 113 were from cars, 34 from trucks, and 32 from other vehicles. Vehicles with no mats had a significantly higher mass of dust (21.3 g) than those with hard mats (9.3 g) but did not differ from vehicles with plush mats (12.0 g). Further research is needed to characterize the environment in which children may be exposed to pesticides.

Keywords farmworkers, floor surface, house dust, pesticides, take-home pathway, vehicle dust

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INTRODUCTION

Organophosphate pesticides (OPs) such as azinphos-methyl are commonly used in the United States, and agricultural and farmworkers are at risk for chronic exposure. A growing body of research has begun to examine the levels of pesticides that enter home environments, where children can become exposed.[1–11] In agricultural communities, individuals are thought to be at risk for exposure through a variety of pathways, including drift from neighboring fields or ingestion of conventionally grown produce. Moreover, farmworkers can track occupationally used pesticides into home environments via vehicles used to commute to and from work.

This translocation of pesticides into homes from occupational settings has been documented in data from several studies.[5,6,12] In a previous analysis using these same data, we report a significant correlation of azinphos-methyl residue levels in a given household to the vehicle (from the same household) used for commuting to and from work.[13] Further studies have documented the presence of agricultural-use-only pesticides in dust samples collected from homes in agricultural communities[8,11,14–17] and have shown higher concentrations in farm homes compared with non-farm homes.[2,3,8,9,11] These data provide support for the notion that pesticides are tracked from occupational setting into home environments, where children and other family members can be exposed.

Children of farmworkers are thought to be uniquely exposed and uniquely susceptible to pesticide residues in the home environment. Children generally spend more time on floors than adults and engage in hand-to-mouth behavior that can result in the ingestion of pesticides. A report by the National Resources Defense Council suggests that farm children are the most highly pesticide-exposed group in the United States.[(18)] Because of the potential for children to become exposed to pesticides and other chemicals in the home environment, the National Children's Study, a longitudinal epidemiologic study of children's health, includes the collection and analysis of indoor dust.[(19)]

Of particular interest for determining at risk conditions for children are studies looking at specific details on house dust contaminants and activity profiles, i.e., where children play most frequently, especially on floors and carpets with specific contaminated areas. Two previous investigations[(20,21)] that have examined the distribution of pesticide residues within homes have reported varying results. Obendorf et al.[(20)] collected dust samples from 41 homes in central New York State (farm, urban, and rural homes) and analyzed them for 17 pesticides. Samples were collected from four locations within a given home: family room carpet, adjacent smooth floor, flat tabletop surface, and settled dust collected in a petri dish on a tabletop. Their analyses showed a higher frequency of detection in carpets compared with hard surfaces. Curwin et al.[(21)] collected dust samples from 25 farm households and 25 non-farm households in Iowa. Dust samples were collected from a variety of locations within the home, including entranceways, father's changing area, laundry room, child's bedroom, and child's playroom. Samples were analyzed for the presence of atrazine, metolachlor, chlorpyrifos, glyphosate, and 2,4-dichlorophenoxyacetic acid (2,4-D). The finding showed higher concentrations of all pesticides within farm homes compared with non-farm homes. Within farm homes, levels of atrazine, metolachlor, glyphosate, and 2,4-D were highest in laundry rooms and fathers' changing areas. Levels of glyphosate and chlorpyrifos were also high in children's bedrooms.

Knowing where within a home pesticide residues are generally found may inform interventions to reduce exposures of vulnerable individuals, such as children. Using dust data from homes and vehicles of agricultural workers having children aged 2–6 collected as part of a community randomized trial to interrupt the take-home pathway of pesticide exposure, we sought to characterize the surfaces and locations within homes and vehicles that azinphos-methyl residues are found.[(4,17,22,23)]

While a handful of previous studies have examined pesticide concentrations in household dust, few studies have examined such concentrations in vehicle dust. This article adds to the existing literature by reporting on characteristics of home and vehicles that correlate with levels of azinphos-methyl in households having a child between the ages of 2 and 6.

METHODS

Setting

This trial was conducted in the Lower Yakima Valley of Washington State. A description of the area has been given in detail elsewhere.[(17)] Briefly, the Yakima Valley is a major agricultural area in the state. Apples, pears, peaches, cherries, grapes, and hops are the primary crops. Many members of the Hispanic population are involved in agricultural work, specifically, in harvesting, pruning, thinning, and other care of the many crops grown in the Lower Yakima Valley.

Study Design

The overall design of the study has been described in detail elsewhere.[(17)] Essentially, this was a randomized community trial involving 24 communities assigned to an intervention or control condition. After forming a Community Advisory Board, we conducted a baseline survey of a cross-sectional sample of farmworkers and a 2-year intervention. The intervention focused on improving knowledge and changing workplace and home practices to minimize pesticide exposures. Following the intervention, a new cross-sectional survey of farmworkers was conducted in the 24 participating communities. Urine samples and house and vehicle dust samples were collected from a subset of participants who had at least one child aged 2–6. The primary trial outcome was changes in urinary metabolite concentrations in adult farmworkers and their children; these findings have been reported previously.[(22)] For this analysis we report on the dust samples collected at the final assessment from a cross-sectional sample of community residents with children aged 2–6.

Participant Enrollment

From randomly selected households, all adult agricultural workers were identified and their first names and birth dates listed on a questionnaire roster. From each household, one farmworker was selected (based on the adult with the first birthday after April 1) to complete an in-person interview. Farmworkers with a child aged 2–6 in the household were asked to participate in a part of the study where dust was collected from the home and from the vehicle driven to work. Our analysis focuses on this subset of households that provided dust samples.

All respondents were asked to give verbal consent to participate; they were given a $5 coupon to a local grocery store as an incentive. Adult participants who agreed to take part in the specimen collection were given $50 and the participating child was given a small stuffed toy. For this part of the study, adult respondents signed informed consent. The study protocol and data collection procedures were reviewed and approved by the Human Subjects Review Board at the University of Washington (Number 98-6567-C) and the Institutional Review Board (IRB) at the Fred Hutchinson Cancer Research Center (IRB # 5101).

Dust Sample Collection

Dust samples were collected by four locally hired and trained bilingual interviewers. Each completed 6 hr of training in dust collection conducted by staff at the University of Washington. The training addressed methods for operating the vacuum cleaner, choosing the site within the home to collect dust, collecting dust based on surface type, choosing the commuter vehicle, collecting dust from the vehicle, and rules for documenting surface type and location. Dust collection for the final assessment took place between June 1, 2002, and September 30, 2002.

Sampling protocols were based on standard operating procedures developed at the University of Washington and are reported in detail by Curl et al.[13] To minimize the possibility of introducing bias, at least 1 week prior to dust collection, participating families were asked not to change their usual house cleaning practices.

Using a Nilfisk GM-80 vacuum cleaner (Nilfisk, Malvern, Pa.), house dust was collected from the residences of the farmworkers. A cleaned vacuum and fresh polyliner bag, along with a clean vacuum hose and wand, were used for each household. Areas were vacuumed in a standardized manner. A square half meter by half meter template was used as a guide. Depending on flooring type, 3 to 10 templates were vacuumed to attempt to collect sufficient dust to analyze OPs. The area vacuumed was where the parent reported "the child played most frequently," as we were interested in child pesticide exposure. As a result, the majority of samples were collected from living rooms. After dust collection, the vacuum bag and polyliner were removed and placed in a plastic bag and stored at -10°C for transfer to the laboratory at the University of Washington for analysis. Vehicle dust was collected in a similar manner. In the vehicle most commonly used to commute to and from work, footwells (front and rear, except in the case of trucks without rear footwells) were thoroughly vacuumed without removing the mats from the vehicle. Wipe samples were not collected from door panels or steering wheels.

Laboratory Analysis

Dust samples were analyzed for azinphos-methyl residues according to the extraction and gas chromatography procedures described by Moate et al.[13] Azinphos-methyl was the pesticide in most common use in the valley during the time we collected the dust.

Statistical Analysis

For the purposes of statistical analysis, we report the geometric mean (GM) concentrations of azinphos-methyl for each location within the home (living room vs. other rooms), surface type (thick carpet, thin carpet, and smooth floor), vehicle type (auto, truck, and other), and vehicle floor mat type (plush mat, hard surface mat, and no mat). In this article, we made the a priori decision to focus on the analysis of azinphos-methyl, as it was the most commonly detected pesticide in house and vehicle dust.[13,17]

We generated cumulative distribution plots to display the relative differences in concentrations of azinphos-methyl by location within the home (living room vs. other room) and surface type (thick carpet, thin carpet, or smooth floor), and by vehicle type (auto, truck, or other) and vehicle floor type (plush mat, hard surface mat, or no mat). "Other" vehicles were primarily vans. Since the surface area vacuumed in the home differs by surface type, we report the house dust values as grams per square meter and the vehicle values as total grams.

We can answer the question of "Where is the dust?" in three different ways, that is, by quantifying

(1) the mass of dust in grams per square meter for homes or mass of dust in grams for vehicles,
(2) the concentration of azinphos-methyl in the dust in nanograms of pesticide per gram of dust, and
(3) by multiplying these two measures to estimate the loading of azinphos-methyl in nanograms per square meter for homes and nanograms for vehicles.

We expressed the dust from vehicle footwells in grams because we vacuumed the entire footwell, and the dust from the house in grams per square meter because we vacuumed a variable portion of the floor surface, depending on floor surface type, of the area (0.75 to 2.5 m^2) where the child played. Building on the work of others,[12,24] we chose to estimate the mass of azinphos-methyl by multiplying the mass of dust by the concentration of azinphos-methyl.

A single sample was collected in each home for the area where the child played most often, and the description of this area could be classified in two different ways—either by room type or floor type. Based on the descriptions of room types, we classified the rooms into two categories of either living room or other room, with about 90% of the rooms being living rooms. Other rooms included bedrooms, dining rooms, or some combination of multiple rooms. The dust samples from vehicles could be classified in two ways either by vehicle type (automobile, truck, or other) or by vehicle flooring type of plush mat, hard mat, or no mat.

We used a hierarchical Bayesian model evaluated in the Markov chain Monte Carlo (MCMC) software WinBUGS[25] to estimate GMs and GSDs and to estimate the probability of whether two groups differed. MCMC modeling allows unbiased analysis of censored and missing data. The log-transformed data were modeled as multivariate normal distributions with conjugate, non-informative priors. The GM and GSDs were calculated from the posterior mean and variance distribution parameters from these models, using 100,000 MCMC iterations after a burn-in of 10,000 iterations. P-values were calculated for a two-sided test of the null hypothesis that the GMs were equal. P values were adjusted in six groups for multiple comparisons using the false discovery rate correction of Benjamini and Hochberg.[26] The six groups correspond to whether the dust was from house or vehicle and the three ways in which we analyzed the dust—the dust mass, azinphos-methyl concentration, and azinphos-methyl loading.[25,26]

RESULTS

Response Rates

A total of 236 households had children aged 2–6; of these, 207 agreed to participate in the sample collection, for a response rate of 87.7%. House and vehicle dust were collected from 203 and 179 households, respectively. The remaining households refused or did not own a vehicle for sampling.

Twenty-four homes and eight vehicles had samples with quantities of dust that were too small for laboratory analysis. The limit of detection was 75 ng/g for azinphos-methyl. In the analyses of concentrations, samples below the limit of detection were treated as being censored on the left with the limit of detection as the censoring point. In the analyses of the loading of azinphos-methyl (computed as the product of the concentration and mass of dust or dust per square meter), the censoring point was the product of the concentration limit of detection, 75 ng/g, and mass of dust or dust per square meter.

A total of 183 samples were collected from living rooms, and 20 were collected from other rooms in the home. Forty-two samples were collected from thick carpets, 130 from thin carpets, and 27 from smooth floor surfaces. Four samples were collected from multiple or non-specified surfaces and were not included in the analysis. A total of 179 samples were collected from vehicles: 113 from cars, 34 from trucks, and 32 from other vehicles. Forty-four percent of vehicle surfaces were plush mats; the remaining 35% and 21% were hard rubber mats and no mats, respectively.

Home Dust

Table I characterizes the dust collected by room type or floor surface type and shows GMs and GSDs for the distribution of mass of dust per square meter, concentration of azinphos-methyl in nanograms per gram of dust, and the loading of azinphos-methyl in nanograms per square meter. Living rooms and other rooms in the home were similar in total mass of house dust and concentrations of azinphos-methyl in the dust. The GM loading of azinphos-methyl in living rooms was slightly lower than in other rooms in the house, although the difference was not statistically significant ($p = 0.06$). Smooth floor surfaces had significantly less mass of dust than thin carpets ($p = 0.002$) or thick carpets ($p = 0.012$) (Table I). Smooth floor surfaces were found to have 670 ng of azinphos-methyl per square meter, and this was about four-fold higher than that found in thin carpets (2490 ng/m^2, $p = 0.08$) and thick carpets (3050 ng/m^2, $p = 0.08$), but the differences were not significant. No differences were observed between thin and thick carpets in total mass of dust, concentrations of azinphos-methyl, or GM loadings of azinphos-methyl.

Vehicle Dust

Table II characterizes the dust collected in vehicles in a similar manner as homes except here we measured the mass of dust in grams collected from the vehicle floors (as a standard unit of measurement) instead of grams per square meter. The average mass of dust found in trucks was 17.3 g, nearly two-fold higher than that found in other vehicles, but the difference was not significant. Slightly higher concentrations of azinphos-methyl and GM loading of azinphos-methyl were observed in truck and other vehicles than in autos, though the differences were not statistically significant. Vehicles having no footwell mat had significantly higher average mass of dust (21.3 g) than vehicles with a hard mat (9.3 g). The average mass of dust collected from plush mats was 12 g, a value that did not differ significantly from vehicles having no mats or having hard mats. No significant differences were observed in concentrations of azinphos-methyl or GM loading of azinphos-methyl across vehicle footwell surfaces. The cumulative distributions for the GM loadings of house and vehicles dust are shown in Figures 1 and 2. Notably, in comparisons by room type, the confidence intervals are broad because only about 10% of the room types were other rooms.

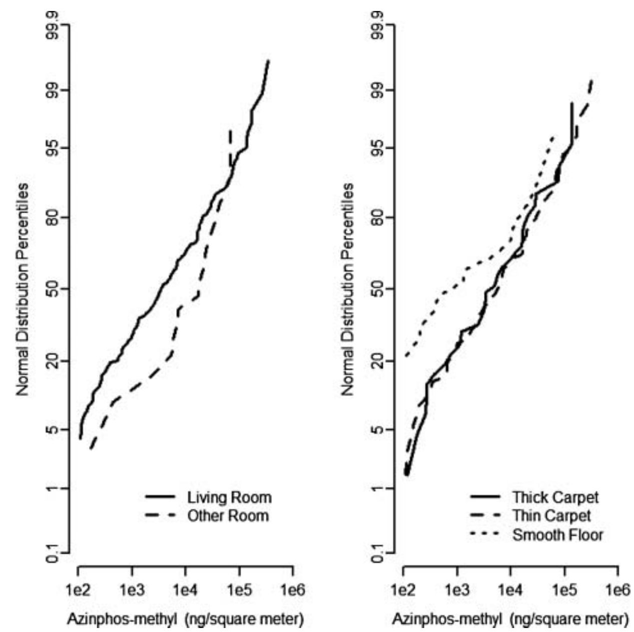

FIGURE 1. Mass of azinphos-methyl per square meter in house dust classified by room type or room flooring surface type.

DISCUSSION

Using house and vehicle dust samples from agricultural worker households, we examined the associations of floor surface type and sampling location to total mass of dust collected, concentrations of azinphos-methyl, and GM loading of azinphos-methyl, an agricultural pesticide commonly used in the Yakima Valley. Our findings suggest that dust samples collected from homes having thin or thick carpets had 3.7- to 4.5-fold higher loading of azinphos-methyl than dust samples collected from homes having smooth floor surfaces. Greater total dust mass was found in vehicles with no mats (compared with vehicles having hard or plush mats). Few differences, however, were observed in concentrations of azinphos-methyl in vehicle dust samples collected from different vehicle types

TABLE I. Mass, Concentration, and Loading of House Azinphos-Methyl

	Mass of Dust			Concentration of Azinphos-Methyl			Azinphos-Methyl Loading		
	N	GM (95% CI) g/m^2	GSD (95% CI)	N	GM (95% CI) ng/g dust	GSD (95% CI)	N	GM (95% CI) ng/m^2	GSD (95% CI)
Room type									
Living	183	5.5 (4.2, 7.3)	6.7 (5.6, 8.3)	162	270 (220, 340)	4.2 (3.5, 5.1)	162	1950 (1320, 2840)	11.1 (8.5, 15.4)
Other	20	7.9 (3.1, 19.6)	7.4 (4.5, 17.8)	17	540 (300, 970)	3.2 (2.3, 6.0)	17	7710 (2820, 20700)	7.0 (4.1, 19.4)
Flooring type									
Smooth	27	1.5 (0.7, 3.4)*	8.1(5.1, 16.8)	19	240 (120, 440)	3.7 (2.5, 7.5)	19	670 (170, 2380)	14.7 (6.9, 59.8)
Thin carpet	130	7.8 (5.7, 10.7)*	6.1 (5.0, 7.8)	119	270 (200, 350)	4.3 (3.6, 5.6)	119	2490 (1580, 3870)	10.8 (7.9, 16.2)
Thick carpet	42	6.0 (3.5, 10.1)*	5.6 (4.1, 8.9)	37	370 (240, 570)	3.8 (2.9, 5.7)	37	3050 (1450, 6310)	9.1 (5.8, 18.0)

*P-values for two-way comparisons adjusted for multiple comparisons were .002 for smooth floor vs. thin carpet; .012 for smooth floor vs. thick carpet; and .5 for thin carpet vs. thick carpet.

TABLE II. Mass, Concentration, and Loading of Vehicle Azinphos-Methyl

	Mass of Dust			Concentration of Azinphos-Methyl			Azinphos-Methyl Loading		
	N	GM (95% CI) g	GSD (95% CI)	N	GM (95% CI) ng/g dust	GSD (95% CI)	N	GM (95% CI) ng	GSD (95% CI)
Vehicle type									
Truck	34	17.3 (10.9, 27.7)	3.9 (2.9, 5.8)	34	410 (190, 820)	7.4 (4.6, 16.4)	34	6120 (1980, 17100)	19.3 (9.5, 61.7)
Auto	113	12.1 (9.3, 15.7)	4.1 (3.5, 5.0)	109	370 (270, 490)	4.8 (3.9, 6.2)	109	4710 (3200, 6860)	7.2 (5.6, 10.0)
Other	32	9.3 (5.2, 16.5)	5.0 (3.6, 8.3)	28	490 (250, 930)	5.4 (3.6, 10.3)	28	6470 (2560, 16000)	10.3 (6.0, 25.6)
Vehicle flooring type									
Hard mat	62	9.3 (6.6, 13.1)*	3.9 (3.2, 5.2)	58	470 (300, 730)	5.4 (4.0, 8.1)	58	4900 (2750, 6590)	8.4 (5.9, 14.1)
Plush mat	77	12.0 (8.9, 16.3)	3.8 (3.2, 4.9)	76	390 (270, 570)	5.1 (3.9, 7.1)	76	4840 (2850, 8080)	9.4 (6.6, 15.1)
No mat	38	21.3 (13.1, 34.2)*	4.4 (3.3, 6.7)	36	330 (180, 580)	5.3 (3.6, 9.6)	36	7410 (3170, 16400)	10.5 (6.2, 23.8)

*P-value for two-way comparison adjusted for multiple comparisons was .04 for no mat vs. hard mat.

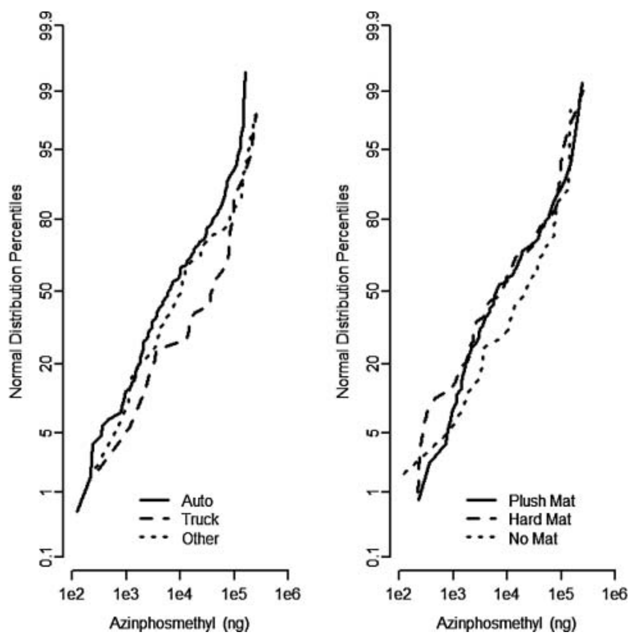

FIGURE 2. Mass of azinphos-methyl in vehicle dust classified by vehicle type or vehicle flooring surface type.

(car, truck, other) or from different footwell surfaces (hard mat, plush mat, no mat).

Our findings show that smooth floor surfaces collect fewer pesticides than carpeted surfaces. A growing body of evidence suggests that pesticides enter the home environment via the take-home exposure pathway;[22,27] our findings might suggest that smooth floor surfaces represent a relatively low exposure option for homes in agricultural settings.

Alternatively, smooth floor surfaces may be easier or more feasible to clean than thin or thick carpets. This is consistent with data reported by Early et al.[28] showing that while nearly one-third (32%) of farmworker households reported that their homes were vacuumed on a daily basis, over three-quarters (78%) reported their floors were swept on a daily basis.[28] Similarly, in a study that collected dust samples from 41 farmworkers residences having a child under the age of 7 in Western North Carolina, Quandt et al.[29] reported that households that were judged to be difficult to clean had higher levels of pesticides in their house dust samples. Given the cost differential between a mop and a vacuum cleaner, combined with the overall low levels of household income report by respondents in our study and among agricultural communities in general, smooth floor surfaces may be cleaned more frequently because it is more economically feasible to do so. Data from the aforementioned study support this assertion, showing that of the 41 households enrolled, 13 (31.7%) did not possess a vacuum, and household members instead cleaned carpets with water or a broom.[28]

While our study did not examine the relationship between type of floor surface and urinary metabolite concentrations, one other study did. Arcury et al.[30] conducted a case comparison of nine homes in North Carolina and Virginia and found that families that did not own a vacuum cleaner or that had carpeting in a high percentage of rooms had higher urinary metabolite concentrations of OPs compared with families that owned vacuum cleaners or had fewer carpeted floors, suggesting that floor surface type and vacuum ownership might influence personal exposure levels. Previously, we report a significant correlation between household dust concentrations of azinphos-methyl and child urinary metabolite concentrations of dimethylthiophosphate (DMTP).[4]

Our finding that thick and thin carpets had greater amounts of overall dust than smooth surfaces is consistent with the findings of a previous study. Obendorf et al.[20] collected dust samples from 41 farm, rural, and urban homes in central New York State. Analysis of samples collected from four locations within the home: family room carpets, adjacent smooth floor surfaces, flat tabletop surfaces, and settled dust in a petri dish on a tabletop within the home, showed greater quantities of pesticide residues in carpets, compared with smooth floor surfaces. The differences were particularly notable in rural farm households where the farmer was a pesticide applicator.

We observed slightly lower concentrations of azinphos-methyl in living rooms, compared with other rooms in the home, although the difference was not significant. One possible explanation for this finding is that a larger share of living rooms may have floor surfaces that are associated with lower levels of pesticides. Across floor surface types, the lowest concentrations of pesticides were found on smooth floor surfaces. In our sample, 15% of living rooms and 20% of other rooms had smooth floor surfaces.

Few previous investigations of farmworker households have reported on differences in concentrations of pesticides in house dust based on the room in which dust was collected. In a study conducted by Curwin et al.,[12] dust samples were collected from a variety of rooms, including entranceways, father's changing area, laundry room, child's bedroom, and child's playroom. Data from the study showed higher concentrations of several pesticides in the laundry room and father's changing area of farm homes. Consistent with this study, our findings showed nearly four-fold higher azinphos-methyl loading in samples collected from other rooms in the home, compared with the living room.

Our findings are consistent with previous research that examined the location in house dust of lead, a contaminant that might be tracked into the home in a similar manner as pesticides. Sterling et al.,[31] for example, measured levels of lead in 41 randomly selected households, of which 31 were located in a lead mining superfund site, and 10 were in a rural town with no history of lead mining. Samples were collected from up to three areas from the home (the child's bedroom, the entryway, and the room where the child spent the majority of his or her playtime (if separate from the entryway). While significance testing was not performed to assess differences by room, the findings using the Nilfisk HSV3 showed average lead concentrations in bedrooms of 110.2 $\mu g/ft^2$ and in living rooms of 87.9 $\mu g/ft^2$. Other studies of lead show that samples collected from the child's bedroom and principal play areas are best correlated with the child's blood lead levels.[32]

Our finding that type of vehicle and type of vehicle floor mat were both unassociated with concentrations of azinphos-methyl found in the vehicle is notable. We previously report higher concentrations of azinphos-methyl in vehicle dust compared with house dust (geometric μ/g),[13] suggesting that pesticides are tracked into the home via vehicles driven to and from work. Our current findings suggest similar opportunities for pesticide exposure across type of vehicle and type of mat used. We did not collect data on the frequency with which individuals cleaned their vehicles, a factor that may lower observed levels. Further, little is known about the influence of vehicle pesticide dust levels on personal pesticide exposures; additional research is needed to characterize this relationship.

A limited number of previous investigations have attempted to reduce pesticides or other toxicants in the home. The Healthy Homes Project, for example, tested a high-intensity intervention, involving eight visits by a community health worker and a variety of resources (allergy control pillow and mattress encasement, low emission vacuums, commercial quality door mats, cleaning kits, referral to smoking cessation counseling, roach bait, and rodent traps) against a low-intensity intervention and assessed differences in quality of life and frequency of asthma symptoms (days).[33] The finding showed significant improvements in quality of life in the high-intensity group, compared with the low-intensity group. Moreover, frequency of asthma symptoms declined in the high-intensity group. Similar efforts could be undertaken to reduce pesticide levels in home environments. However, such interventions may be expensive to execute or impractical in areas where housing quality is severely substandard. These factors need to be weighed against the potential benefits of this type of intervention.

Strengths and Limitations

The strength of this study is the large sample size relative to previous studies. Previous investigations have recruited farmworkers from a select number of farms or community organizations. Growers who volunteer their farms for participation in studies may promote protective work practices or have fewer applications of pesticides, potentially biasing collected data. Our household recruitment process attempted to minimize this bias.

The data from this study show a small variability of locations within the home from which dust samples were collected. While we believe that this does not limit the conclusions that can be drawn, future studies would benefit from a more representative distribution of samples from various locations within homes. Previous research has suggested that levels of pesticides found in house dust is influenced by a variety of factors, including the number of farmworkers in the household,[5,6,30] and certain home protective practices;[5] the distribution of our data (resulting in small cell sizes) did not allow us to adjust for these factors.

For practical reasons, our study did not collect dust samples from seats or door panels, even though these areas might be more predictive of personal exposures. We did not collect multiple dust samples from different areas within a given home, although this design may have been advantageous. Because the location sampled was based on the areas within the home where the child most frequently played, our conclusions are limited to this sampling criterion. The generalizability of our findings is further limited by our collection of dust samples only from households with children aged 2–6 as demographic characteristics (gender, age, and marital status), and the pattern of distribution of dust in these households likely differ from households having no young children. Moreover, bias may have been introduced, as we did not control for the length of time between cleaning and sample collection, though we asked participants not to change their usual cleaning practices.

CONCLUSIONS

Our findings demonstrate the potential for pesticide residues to accumulate on carpeted surfaces. This might suggest that smooth surface floors collect fewer pesticides and are easier to clean than thin or thick carpets. Findings from this study can inform interventions that aim to reduce home pesticide exposure in agricultural communities. Future efforts to reduce pesticide exposure among children might focus on interior housing designs that have low exposure surfaces and permit easy cleaning.

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