Work Characteristics and Pesticide Exposures among Migrant Agricultural Families: A Community-Based Research Approach

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There are few data on pesticide exposures of migrant Latino farmworker children, and access to this vulnerable population is often difficult. In this paper we describe a community-based approach to implement culturally appropriate research methods with a migrant Latino farmworker community in Oregon. Assessments were conducted in 96 farmworker homes and 24 grower homes in two agricultural communities in Oregon. Measurements included surveys of pesticide use and work protection practices and analyses of home-dust samples for pesticide residues of major organophosphates used in area crops. Results indicate that migrant farmworker housing is diverse, and the amounts and types of pesticide residues found in homes differ. Azinphos-methyl (AZM) was the pesticide residue found most often in both farmworker and grower homes. The median level of AZM in farmworker homes was 1.45 ppm compared to 1.64 ppm in the entry area of grower homes. The median level of AZM in the play areas of grower homes was 0.71 ppm. The levels of AZM in migrant farmworker homes were most associated with the distance from fields and the number of agricultural workers in the home. Although the levels of AZM in growers and farmworker homes were comparable in certain areas, potential for disproportionate exposures occur in areas of the homes where children are most likely to play. The relationship between home resident density, levels of pesticide residues, and play behaviors of children merit further attention. *Key words*: agriculture, azinphos-methyl, children, environmental exposure, environmental justice, migrant farmworkers, pesticides. *Environ Health Perspect* 109:533–538 (2001). [Online 14 May 2001]
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Pesticides are among the environmental contaminants that represent potential sources of health risks (*1*). Although all populations have a degree of risk in relation to pesticide exposures from nonagricultural use and through residues on food, there are certain subgroups of the population with a higher risk of exposure and potential health effects. The special health concerns and research needs of the migrant farmworker population have been addressed by national groups (*2–4*). Migrant farmworkers are among the most disadvantaged, medically indigent persons and have the poorest health of any group in the United States (*5,6*). The lack of national research and hard data on migrant and seasonal farmworkers has hindered efforts to improve the health of this population (*3*). Occupational and environmental diseases including health problems related to pesticide exposure in this minority population warrant increased attention.

Agricultural workers can inadvertently carry hazardous materials home from work on their clothes, skin, hair, and tools, and in their vehicles. Because of the nature of agriculture and the proximity of homes to the fields, it may be difficult to separate exposures at work and exposures at home. Studies designed to characterize children's exposures to pesticides in the general population indicate that the largest number of pesticides and the highest concentrations are found in household dust compared to air, soil, and food (*7,8*). Pesticide exposure can occur from a number of sources such as contaminated soil, dust, work clothing, water, and food, or through drift—the deposition of a pesticide off target. In many migrant farmworker communities, home sites are close to or surrounded by fields or orchards. Pesticides may persist in indoor environments longer than in outdoor soil due to the lack of degradative environmental processes such as sun, rain, and soil microbial activity. Investigations in the last decade have documented levels of pesticides in homes of farmers and nonseasonal farmworker families living within 200 feet of an orchard compared to referent families (*9*). The authors found organophosphate (OP) compounds in 62% of household dust samples of agricultural families in Washington State. There have been no published reports of the pesticide residues in the housing of migrant farmworkers. Factors specific in the migrant farm-family environment could potentially increase pesticide levels in the home, specifically, the close proximity of housing to the fields where spraying occurs, the substandard housing in which migrant families often live, the number of persons living in the dwelling, and inadequate laundry facilities to cleanse clothing of pesticide residues and multiple family members working in the agricultural fields. Almost one-half of migrant farmworkers live in housing with family members (*10*). Studies are needed to document the exposure patterns of children residing in crowded, substandard housing. However, given the migratory patterns and temporary labor characteristics of this population, they are often not studied in research investigations.

Materials and Methods

The migrant Latino farmworker families recruited for our project were obtained through a community partnership with the Oregon Child Development Coalition (OCDC), a private, not-for-profit corporation with central offices located in Wilsonville, Oregon. The OCDC was organized in 1971, under the name of the Migrant Indian Coalition, to address the needs of migrant and seasonal farmworkers as well as Native American families. In 1975 the organization became the grantee for the Migrant HeadStart (MHS) program in Oregon. The OCDC directly administers and operates MHS programs serving 1,800 migrant Latino children (from birth through 5 years of age) and their families at nine centers throughout Oregon. The program provides child care, medical, dental, and social services during the migrant farmworker season (May–November). With nine centers throughout the state, the program serves 40% of all 3–6-year-old migrant children in the state and 75% of eligible children in the

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geographic areas where centers are located. The OCDC is an established minority organization with proven ability to access and serve minority populations.

In the summer of 1997, we obtained a convenience sample of 96 migrant Latino families who had preschool children enrolled in MHS centers in Washington and Hood River Counties in Oregon. Information was obtained on the work characteristics of all adult family members residing in the home, self-reported protection practices at work and upon coming home, and residential pesticide use. In a subset of families, we obtained detailed information on the physical characteristics of their housing, and we also obtained home dust samples for the measurement of pesticides. Of the 96 families, 59 had carpets from which we could obtain dust residues using our high-efficiency vacuum sampler. (We concluded that wipe samples from uncarpeted floors would give variable results.) Of the 59 families, dust samples were collected from 49 homes. The remaining 10 homes were not sampled due to timing constraints and equipment availability. No family refused access.

Target population. We recruited families from the MHS centers in two agricultural areas of northwest Oregon. Hood River County has primarily fruit orchards, and Washington County has a combination of berry and vegetable crops and nurseries. Washington County is in the rural surburban area of Portland, Oregon. Hood River County is approximately 70 miles east of Portland. Families arrive earlier in the year in Washington County due to the months of harvest. In 1997 the MHS center in Washington County enrolled approximately 110 families with children ≥ 3 years of age. Approximately one-half of the families live in migrant labor camps and one-half rent other types of housing in the area. The average enrollment in the MHS centers in Hood River County is 80–100 families. The housing for migrant farmworker families in Hood River County tends to be a small number of temporary structures on individual grower property and rental units in the small towns nearby. Large migrant labor camps are not seen frequently in the Hood River area.

Recruitment of families was carried out by a number of steps. In Washington County, recruitment began when we placed a poster advertising the study in the MHS center. As families moved into the area, MHS enrollment sheets were reviewed each week to identify new eligible families. Spanish-speaking research assistants and OCDC staff provided study information at two health fairs, where children enrolled in the MHS were receiving their health screenings and also at an MHS open house on the first day of classes. As more migrant families began arriving at the labor camps, recruitment was done by contacting families when they enrolled their children or visited the center, or by visiting the homes of families with children enrolled in the MHS. Similar recruitment methods were used in Hood River County. We continued recruitment with the goal of obtaining 50 families from each area. In no circumstance did we recruit multiple families who shared the same housing, although it was common to find homes where more that two adults were living in the home and working in agriculture. Recruitment ended when we had met our recruitment goals or when the families began moving to other farming communities.

Measurements and instruments. As a major component of our project, we focused on the need to better understand the underserved migrant farmworker community and to incorporate feedback from representatives of that community at every step of the research process. We had parent representation on our research advisory committee. The members of the migrant community and the parents of migrant children provided substantive input on when and who should contact families for participation, the appropriateness of advertisements, and the appropriateness of the teams that are put together to collect data in migrant family homes.

The primary language of the Latino migrant population in Oregon is Spanish, and many speak indigenous languages from Mexico or other Latin American countries. Few families speak English as a secondary language. To increase the cultural appropriateness of our study methods and instruments, we completed multistep translations and interpretations of all study instruments and consent forms. We then modified the forms to be read more easily to potential subjects. Questionnaires and consent forms were pilot-tested with migrant families for understanding of the content. All unclear examples or sentences in questionnaires were removed or substituted with content that was relevant to the migrant families' experiences.

Four questionnaires were used: the Demographics Sheet, the Agricultural Work Practices Questionnaire, the Pesticide Inventory, and the Pesticide Use Survey. The Demographic Sheet was developed for the purposes of this study and contained information on the number of members within the family unit, and the age, sex, years of education, the type of housing, and the employer(s) of the parents. We also developed the Agriculture Work Practices questionnaire, which contained items on type of work (e.g., thinning, picking, packing, pesticide application, flagging), type of crop(s), hours worked per week, use of insect repellents, use of protective clothing, bathing and laundry habits, and wearing of work clothes outside of fields.

We developed a pesticide inventory with which we could record observations on the presence and storage of pesticides in the home, as well as the housing structure, ventilation, the type of cooling system, and the presence of carpeting. The Pesticide Use Survey was developed to obtain information from the family on home pesticide use and storage, the use of precautionary actions, and adverse effects from the application of pesticides in the home. All of these questionnaires were pretested on Spanish-speaking adults and have been used or adapted for other studies with migrant farmworker and grower populations (*11–14*).

Land use information (including proximal crops) was collected during home visits and with the use of digitized local tax-lot datasets. We used a geographic information system (GIS) database (MapInfo; MapInfo Corporation, Troy, NY) to create maps and analyze the spatial distribution of homes and land use proximal to housing. We also collected farm and labor camp boundaries and distances from family housing to crops using a handheld global positioning system (GPS) unit (Apollo GPS; UPS-Aviation Technology, Salem, OR). Data were also collected on a smaller scale to create a layout of the dwellings of families residing in labor camps (i.e., housing, showers, cooking facilities, etc.) and the layout of the individual cabins (windows, doors, stove, etc.). We collected additional descriptive data including housing density, housing structure, shower, bathroom, laundry, and cooking facilities.

We collected house dust samples in dwellings with carpeted floors using the HVS3 High Volume Small Surface Sampler (Cascade Stack Sampling Equipment, Bend, OR). A surface wipe procedure using glass fiber filters (Fisherbrand G6 glass fiber circles; Fisher Scientific, Pittsburgh, PA) and cotton swabs wetted with isopropanol (Mallinkcrodt, Chesterfield, MO) was used to collect samples from dwellings with hard floor surfaces. All samples and wipes were transferred to glass or teflon bottles, placed immediately in an insulated, ice-cold container, transported to the laboratory within 12 hr of collection, and stored at –20°C pending analysis within 12 months of collection.

Dust samples and glass fiber filters/cotton swabs were prepared and analyzed using sonication, gel permeation chromatography, and gas chromatography/mass spectrometry (GC/MS) methods adapted from Simcox et al. (*9*). All analyses were conducted with a Hewlett Packard 5890 Series 2 gas chromatograph equipped with a 5972 Mass Selective Detector and autosampler (Agilent

Technologies, Palo Alto, CA). None of the pesticide residues that we measured were above detection limits [0.1 ppm for azinphos-methyl (AZM), 0.05–0.1 ppm for other pesticides of interest] in solvent, glass fiber filter, and cotton swab blanks (data not shown). Recovery efficiencies of spiked dust samples demonstrated a mean recovery of 98% for AZM and 94–98% for other pesticides of interest. Analytical results reported in this paper are not corrected for recovery efficiency.

Results

Demographic characteristics of sample. Ninety-six families were recruited for participation in the study: 52 in Washington County and 44 in Hood River County. Whereas all of these families had at least one adult who planned on working in agriculture during that harvest season, 87 families had at least one family member who had already begun fieldwork at the time of recruitment. The remaining 9 families had just arrived in Oregon and were waiting for work to begin. Forty-nine percent of the 96 families indicated that they came to Oregon directly from Mexico, 34.4% came from California, 9.4% came from Washington, and 6.2% came from other states. The majority indicated they lived ≤ 6 months in the previous location, and 83.1% indicated they did some type of agricultural work at their previous location. The average number of moves the families made in the last 12 months was 1.5 (SD = 1.1). The average family size was 4.8 persons (range = 3–10 persons). In these 96 families, 166 adults reported that they were currently working in agriculture.

The mean age for the 166 adult migrant agricultural workers was 30.1 years (SD = 7.1); the youngest worker was 19 years of age and the oldest was 53 years of age (Table 1). The workers in Hood River and Washington Counties did not differ in their mean ages (p = 0.23), but workers in Washington County were 2.3 times more likely to be under 30 years of age than were workers in Hood River County [odds ratio (OR) = 2.3, 95% confidence interval (CI), 1.21–4.27]. There were 94 (56.7%) males and 72 (43.4%) females working in agriculture. There were no statistical differences in sex between the two locations (p = 0.54).

The education level of the 166 adults ranged from 0 to 13 years, with a mean of 5.4 years (SD = 3.3). Adults in Washington County (n = 97) had a mean education level of 4.4 years (SD = 3.1) compared to a mean of 6.8 (SD = 2.9) years for adults in Hood River County (p < 0.001). Adults in Hood River County spoke Spanish as their primary language; however, 39 (43.3%) of the adults from Washington County spoke indigenous languages. Of the 39 who spoke indigenous languages, 30 (76.9%) spoke Mixteco, 7 (17.9%) spoke Trique, and 2 (5.1%) spoke Kanjobal. Only 26 adults in the total sample indicated that they spoke English as a second language.

Agricultural work practices. The majority (79.8%) of the 166 migrant farmworkers were fieldworkers and 16.3% were packers (Table 2); 2 workers in Washington County were pesticide applicators. Workers performed multiple job tasks because workers do many jobs over a season and over a year. Workers in Washington County primarily pick berry crops (blackberries, blueberries, raspberries, and strawberries), often different types, and workers in Hood River County primarily prune, thin, and pick orchard crops (apples, cherries, peaches, and pears). Although 2 workers indicated that they were pesticide applicators, 21 workers indicated that they mixed or applied pesticides, herbicides, or fungicides in their current jobs. There were no statistical differences between workers who mixed or applied pesticides and whether they worked in Washington County or Hood River County (p = 0.78). These individuals were predominately male (95.2%) and all spoke Spanish as their primary language.

Only 27 farmworkers (18.1%) indicated that they wore some type of protective clothing for their job (Table 2). Protective clothing included a respirator, a bandanna over mouth or nose, glasses or goggles, sun hat or cap, and/or coveralls. Use of protective clothing did not differ according to location area (p = 0.45). When asked whether workers entered their homes with their work clothes on, 109 of 144 indicated that they did. Workers in Hood River County were more likely to enter their homes while wearing their work clothes than workers in Washington County (p = 0.001)

The majority (n = 98; 66.7%) of workers changed out of their work clothes within 30 min of getting home. Workers in Washington County were 2.6 times more likely to change out of their work clothes within 30 min of getting home than were workers in Hood River County (OR = 2.6; 95% CI, 1.3–5.1). Ninety-nine (61.5%) of the workers indicated that they removed their work shoes before entering their homes. Workers in

Table 1. Characteristics of the 166 adults who lived in the residences of the 96 migrant families recruited from Washington and Hood River Counties.

Characteristics	Washington (n = 97)	Hood River (n = 69)	Total (n = 166)
Age (mean ± SD)	29.5 ± 7.6	30.8 ± 6.4	30.1 ± 7.1
Sex[a]			
Male	53 (54.6)	41 (59.4)	94 (56.7)
Female	44 (45.4)	28 (40.6)	72 (43.4)
Years of education (mean ± SD)	4.4 ± 3.1	6.8 ± 2.9	5.4 ± 3.3
Primary language[a]			
Spanish	51 (56.7)	65 (100)	116 (78.0)
Indigenous languages	39 (43.3)	0	39 (22.0)

[a]Values shown are number (%).

Table 2. Agricultural work and home practices among 166 adult migrant farmworkers from Washington and Hood River Counties.

Work practices (no. missing)	Washington (n = 97)	Hood River (n = 69)	Total (n = 166)
Job category (6)			
Mix/formulator	0 (0.0)	1 (1.6)	1 (0.6)
Applicator	2 (2.1)	0 (0.0)	2 (1.3)
Packer	14 (14.6)	12 (19.1)	26 (16.3)
Fieldworker	77 (80.2)	48 (76.2)	125 (79.8)
Foreman	3 (3.1)	2 (3.2)	5 (3.0)
Mixes or formulates pesticides (1)			
Yes	13 (13.4)	8 (11.9)	21 (12.8)
No	84 (86.6)	59 (88.1)	143 (87.2)
Wears protective clothing (16)			
Any	14 (16.1)	13 (21.0)	27 (18.1)
None	73 (83.9)	49 (79.0)	122 (81.9)
Enters home with work clothing (22)			
Yes	51 (64.6)	58 (89.2)	109 (75.7)
No	28 (35.4)	7 (10.8)	35 (24.3)
Changes work clothes when home (18)			
< 30 min	66 (76.7)	32 (52.5)	98 (66.7)
≥ 30 min	20 (23.3)	27 (47.5)	49 (33.3)
Removes work shoes/boots before entering home (5)			
Yes	70 (73.7)	29 (43.9)	99 (61.5)
No	25 (26.3)	37 (56.1)	62 (38.5)

Values shown are number (%).

Washington County were 3.6 times more likely to remove their work shoes before entering their homes than workers in Hood River County (OR = 3.6, 95% CI = 1.8–7.0). This difference could be attributable to the differences in weather conditions in the two counties: it rains often during harvesting in Washington County in June, but it is much dryer during orchard harvesting in Hood River County in September.

Twenty of the 21 workers who mixed or applied pesticides responded to the question about protective clothing: 14 of the 20 workers wore some type of protective clothing. Two workers indicated that their job category was pesticide applicator. Both of these workers reported that they wore coveralls; one wore both coveralls and a respirator. Nine (45%) of the 21 workers who mixed or applied pesticides reported that they entered their homes with their work clothes on, 12 (66.7%) changed out of their work clothes within 30 min of getting home, and 10 workers (47.6%) removed their work shoes before entering their homes.

Farmworker housing characteristics. In Washington County the 52 study families lived in a variety of housing including large labor camps, trailers, and apartments. Labor camps tended to be in close proximity to agricultural fields, with 70% of the labor camps within 30 m of agricultural fields or nurseries. Eighty percent of the nonlabor camp residences were within 200–1,000 m of agricultural land. In the Hood River sample of 44 families, 70% of their residences were within 30 m of orchards. The areas in front of the homes tended to be common areas, with the majority (n = 70, 80.5%) being bare earth. Families in Washington County were more likely to have a bare common area in front of their homes than families in Hood River County. Very few families had grass and other plants in front of their homes (n = 6, 6.2%). Interviewers asked whether there was a floor mat for residents to wipe their feet before entering the house. Fifty-three (55.8%) of the farmworker dwellings had a floor mat; families in Hood River County were more likely to have a floor mat at the door of their homes than families in Washington County.

The majority (n = 90, 93.8%) of families did not have air-conditioning in their homes. Only five (5.2%) had a window air conditioning unit. Ninety-four of the 96 families indicated that they left their doors and windows open for ventilation. The majority (n = 84, 87.5%) of respondents indicated that they left the doors and windows open every day, and 5 (5.2%) indicated that they left doors and windows open more than once per week.

Fifty-eight percent of the Hood River County families and 48% of the Washington County families had washing machines on site. The remainder used public laundry facilities. We found only 6 families in Hood River County that had no running water (13.7%). In the Washington County sample, 21 of 52 families had no running water (40.4%).

Residential use of pesticides. Only six families indicated that they had a cat, dog, or both. Only one family reported the use of flea/tick shampoo or dip on a home pet and the application of flea/tick shampoos, dips, or powders inside their home.

Workers were asked whether they stored or used pest-control products in their homes. Thirty-four percent of the homes in Hood River County and 31% of the Washington County families reported that they stored some type of pesticide in their homes. Thirty-two (62.8%) of the Washington County families reported using some form of pesticide in their homes compared to the 30 (68.2%) of the Hood River families (p = 0.58). Products were stored in a variety of locations, either inside or outside the home. Some families had multiple products, which were stored in multiple locations in the home or in outside sheds.

Household cleaning. The majority (n = 59, 67.8%) of families had carpeted floors in their homes. The likelihood of having carpet in the home did not differ between the two agricultural areas (p = 0.30). Only 42.5% of the families owned a vacuum cleaner. Thirty-eight (58.5%) reported they cleaned their carpeted floors with a vacuum and 19 (29.2%) used a broom. The majority (n = 34, 59.6%) indicated that they vacuumed or swept their carpeted floors daily or several times per week. Eighteen (31.6%) said they vacuumed their floors less than once per week, and all 18 of those were located in Washington County.

Families were asked to describe how they cleaned noncarpeted floors. Of the 65 families who responded to this question, all indicated that they cleaned their floors using either a broom, mop, mop with cleaner, or some combination of these. The majority (n = 38, 55.1%) of workers cleaned their noncarpeted floors daily. Workers in Washington County were more likely to clean their floors daily than were workers in Hood River County. Most families (n = 46, 61.3%) wiped down or dusted permanent surfaces in their homes several times per week. The majority (n = 51, 65.4%) used a damp cloth to wipe surfaces.

Pesticide residue sampling. Dust samples were collected from the residences of 24 families in Washington County and 25 families in Hood River County. These families lived in cabins in which toilet and washing facilities were located in communal areas outside the residence, trailers with private washing and toilet facilities, houses with private washing and toilet facilities, and apartments in generally more urban areas. Table 3 shows the comparison of the homes from which dust samples were obtained in the two communities. The sizes of the homes in the two communities were comparable; however, the homes in Hood River County were located closer to agricultural fields than the homes in Washington County (p = 0.002). The median distance to agricultural fields in Washington County was 48 m compared to 15 m in the Hood River sample. There was no difference in the mean number of persons per residence (p = 0.16). The housing in both communities was very crowded, with less than 150 ft^2/person. Families living in cabins had an average of 74 ft^2/person, whereas those in other housing shared an average of 157 ft^2/person. The average square footage of a cabin was approximately 45% smaller than noncabin housing.

The pesticide residues that were detected in the farmworker homes in the two communities were very dissimilar (Table 4). In Washington County there were 9 detectable residues of four distinct types; in Hood River

Table 3. Comparison of the housing of farmworkers in Washington and Hood River Counties.

Housing	Washington (n = 24)	Hood River (n = 25)
Size (ft^2)	670 ± 89	667 ± 39
Number of persons	6.4 ± 0.72	5.2 ± 0.33
ft^2/person	117 ± 17	136 ± 10
Median distance to field (m)*	48	15
Range	9–920	3–305

*p = 0.002.

Table 4. Frequency of specific pesticide residues found in grower and farmworker homes.

Pesticide	Farmworker Washington (n = 24)	Farmworker Hood River (n = 25)	Grower Hood River (n = 24)
AZM	0	22	19
Captan	5	1	0
Carbaryl	2	0	0
DDT	1	1	0
DDE	0	1	0
Dursban	0	0	7
Malathion	0	0	3
Pentachlorophenol	1	0	0
Phosmet	0	0	7
Piperolyl butoxide	0	1	0

County there were 26 detectable residues of 5 distinct kinds. Three families in Hood River County and 15 families in Washington County had nondetectable levels of pesticide residue in their home dust samples. The most common pesticide found in Washington County was Captan, a chloroalkyl thio fungicide used on both apple and berry crops (Table 4). In Washington County it is applied in April–June on strawberry crops; the reentry time after application is 4 days. DDT was found in one Washington County residence and one Hood River residence, and DDE was found in one Hood River residence.

The organophosphate pesticide AZM was detected in 22 of the 25 farmworker homes sampled in Hood River County. All homes were within 3–305 m of agricultural land, and more than 70% of the families lived within 30 m of an apple or pear orchard. Growers from the region indicated that AZM had not been sprayed on the orchards in the Hood River area during the 30 days preceding our sampling. Figure 1 shows that when the nondetectable dust samples (3 of the 25 samples taken) are not included in the analysis, the median AZM concentration decreased by an estimated 18% when the distance from the field doubled ($p = 0.04$). If the 3 nondetectable samples are incorporated into the analysis by assigning one-half the MLOQ (method limit of quantitation; 0.1 µg/g), the association between the median AZM concentration and distance becomes statistically insignificant ($p = 0.32$).

There was a positive correlation between the number of persons living in each farmworker home and the level of AZM home residue detected. We estimated that the median levels would increase by approximately 40% for each additional person living in the house. There was a stronger correlation between home residue levels and the number of persons in each house who specifically worked in agriculture. The median concentration increased 170% for each additional person working in agriculture ($p = 0.002$), as shown in Figure 2. If nondetectable readings are included, concentrations increase 230% for each additional person working in agriculture. We found no significant correlation between home pesticide residue samples and housing type or square footage of the home. We found no significant correlations between family use of pest control products and residues found in the home.

Comparative grower homes. We compared the data on dust residues from homes of migrant farmworker families to home dust samples of 24 grower families in Hood River County that were collected as part of another investigation. The samples from grower homes were taken in the same time of the year as the migrant farmworker samples, and AZM had not been sprayed in the 30 days preceding sample collection. Dust samples were taken from the entry area and the children's play area in each grower home. Questionnaires (demographics, home pesticide inventory, agricultural work practices, health concerns, child agricultural safety) administered to the grower families were similar to those used with the migrant farmworker families. The pesticide residue levels and characteristics of the grower homes were compared to the migrant farmworker data. The frequency and types of pesticide residues found in the homes of growers are shown in Table 4. AZM was the most common pesticide (found in 19 of 24 homes).

The mean square footage of the 24 grower homes in Hood River County was 2,286 ± 183 compared to 667 ± 39 ft^2 in the 25 migrant farmworker homes ($p < 0.001$). The number of persons residing in the homes differed between the two types of housing with 4.3 ± 0.2 persons/residence among growers and 5.2 ± 0.3 persons/residence among migrant farmworkers ($p = 0.02$). There was 559 ± 55 ft^2/person in grower homes compared to 136 ± 10 ft^2/person in farmworker homes ($p < 0.001$).

All grower homes were large enough to designate a play area; however, homes of migrant workers were typically small and children played in open areas where people often walked. Median levels of pesticides in these open areas of farmworker housing were comparable to those found in the entry area of grower homes (1.45 ppm in farmworker homes compared to 1.64 ppm in grower homes). The levels in the open areas in farmworker homes (1.45 ppm) differed significantly from the levels in the play areas of the grower homes (0.71 ppm, $p = 0.02$).

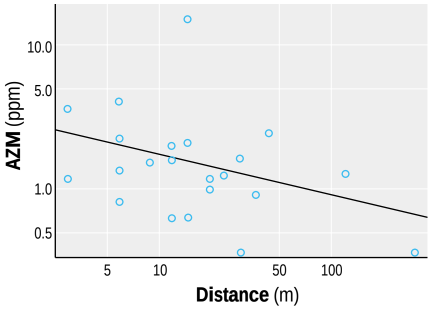

Figure 1. AZM in home dust residues by distance from agricultural fields. $p = 0.04$.

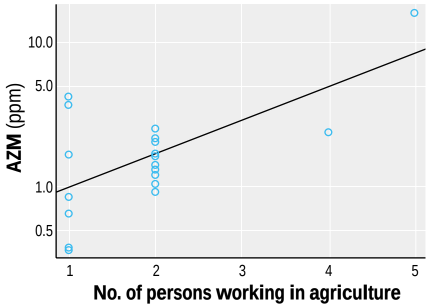

Figure 2. AZM in home dust residues by number of agricultural workers in the home. $p = 0.002$.

Discussion

The migrant farmworker community has been understudied, and there are socioeconomic and cultural factors which suggest that children of farmworkers are at a disproportionate risk for health effects from environmental exposures. Migrant farmworkers provide a crucial labor source for U.S. agriculture. Data suggest that 6 of 10 seasonal agricultural workers reside with a spouse, child, or parent while employed in farmwork (*10,15*). We believe that the Latino families in this study are representative of the larger pool of migrant farmworker families in the United States. Our study sample from Oregon closely parallels the statistics of farmworker families in California, where the median number of children is two and the mean number of children is three. Most seasonal farmworkers in California have completed 8 or fewer years of formal education in the United States and/or their native country (71%). Our study sample had a mean of 5.7 years of education. Spanish is the predominant language, with only approximately 15% speaking English as a second language. Approximately 8% primarily speak indigenous languages. These statistics have important implications for the development of pesticide safety training and health education programs.

Our findings suggest that much improvement is needed in the use of protective clothing and equipment for agricultural workers and in the implementation of decontamination procedures when they return home. In a recent report of farm workers in Yakima Valley, Washington (*16*), about 25% of workers reported that they did not use protective gear and about 50% did not promptly remove and wash contaminated clothing when they went home. No information was provided for the background of the agricultural workers in the Washington State sample, but our results suggest a much greater problem among the migrant population. Only 18% of our sample reported wearing any type of protective clothing or equipment, and the large majority wear their work clothes into their homes. Our study also demonstrated that workers have many misconceptions about proper protective gear, with some workers believing that ineffective devices such as bandanas will provide protection against pesticide exposure. Only 63% of the farmworkers reported that they change out of their work clothes within 30 min of getting home. Only 61% remove their work shoes before entering their homes compared to 74% in the Washington State sample (*16*). The differences between the protective practices could be related to the nature of the work performed. About 30% of the Washington State sample had direct contact applying, mixing, or loading pesticides (*16*), whereas only 13% of our sample reported these work activities. As reported in the Washington survey (*16*), the use of protection in individuals who have direct contact applying, mixing, or loading pesticides is higher than in the general farmworker population.

Our findings suggest that it is difficult to characterize pesticide exposure risks among agricultural communities. There are marked differences in farming communities, the backgrounds of the workers, the types of work that are done, types of crops, pesticides used, and the characteristics of housing available to the workers. Due to the challenges of studying migrant farm workers, most in-depth pesticide research studies have focused on other pesticide-exposed agricultural populations (*17*). We found that a community-based research approach with partners familiar with the migrant farmworker population greatly improved access to this population. Although there are similarities in the potential pesticide exposures in migrant workers versus more geographically stable agricultural workers, such as proximity of residences to agricultural fields and the nature of work activities, differences do emerge. We found few incidences of migrant farmworkers having pets in their homes, therefore resulting in less potential exposure from that mechanism. But residential use of pesticide products in housing did occur at a frequency quite similar to that reported in the nonmigratory Washington sample (29% in the Washington sample compared to 32% in our sample) (*16*). Of interest is that, in both of these agricultural samples, residential use of pesticides is much lower than that reported for the general U.S. population (*17*).

The type of housing available for migrant farmworker families varies, but the constant factor is that the housing conditions are crowded. In the 1995 report of the National Advisory Council on Migrant Health (*18*), the average number of rooms in a single family dwelling for a migrant farmworker family is between 1 and 2.6, and the average dimension of rooms is approximately 10 ft × 12 ft or 12 ft × 15 ft. Indoor running water in the housing unit is available in only 64.8 % of camps, and laundry facilities are generally unavailable. We found very diverse types of housing available for the migrant families that we studied.

Few studies have addressed the nature of pesticide exposures in children of agricultural workers, particularly children of migrant farmworkers. Other investigators have reported that children living in households with pesticide applicators and in proximity to pesticide-treated orchards experienced greater OP pesticide exposures than children of families with no occupational connection to agriculture who reside farther from agricultural spraying (*19*). A limitation of our study was the small number of homes sampled and the distribution of AZM residues in these homes. Because of this small sample size, we have presented the results of analysis of the data both including and excluding the nondetectable samples. Although the association between AZM and distance from the field appears to be driven by a few extreme data points, Cook's distance (a diagnostic measure of influence) does not suggest extreme influence is being exerted by any subset of the data (*20*). Overall, the trend noted between the levels of AZM and the number of agricultural workers in the home and the distance from orchards merits further research. Studies are needed to determine if the differences noted in the pesticide dust residues in grower and farmworker homes result in differences in levels of biomarkers of pesticides in the urine of the children living in these homes.

Although most of the pesticide residues we identified were consistent with the agricultural pesticides used in the area and present at levels comparable to those found by others (*9*), we also identified DDT, DDE, and pentachlorophenol residues in some samples. We are not able to identify the origin of these pesticides in the samples, but their presence suggests that migrant workers and their children may be exposed to a wider range of pesticidal agents than might be expected based on current agricultural practices alone. Our findings suggest that migrant farmworker homes show considerable variability in pesticide residues both between and within communities. Levels of residues may be influenced by distance from fields and the number of agricultural workers in residence. The size of the home and the number of occupants may result in disproportionate exposure risk for children of growers and migrant farmworkers. In studies of dust residues in agricultural homes, samples are usually taken from the entry area of the home and the area of most common play activity by the children (*8,9*). This protocol is difficult to replicate in most migrant farmworker situations. The housing density is so large and there are so few rooms that a common play area cannot be designated. Observational studies are needed to document the play activities and play areas of migrant farmworker children. Furthermore, more child care settings are needed to provide safe play areas for these migrant children. It is only through partnering with community groups acting as advocates for the migrant farmworker community and through using culturally appropriate methods that researchers can gain access to the lives of this vulnerable and understudied population.

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