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Risk Behaviors for Pesticide Exposure Among Pregnant Women Living in Farmworker Households in Salinas, California

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Background *Farmworkers and their families are at risk for pesticide exposure, however, little is known about behaviors that increase their risk. We determined the frequency of risky behaviors among pregnant farmworkers and characterized those at greatest risk.*
Methods *Participants included 153 pregnant farmworkers and 248 pregnant non-farmworkers who resided with farmworkers from the CHAMACOS (Center for the Health Assessment of Mothers and Children of Salinas) study. We examined risky behaviors relating to handwashing, bathing, protective clothing, house cleaning, laundering of work clothes, wearing of work clothes and shoes into the home, and eating produce from the fields.*
Results *Between 25 and 60% of women demonstrated risky behavior on each item. Practices of households with pregnant farmworkers and non-farmworkers did not differ. Women who lived in the United States longer, and in crowded households demonstrated the most risky behavior overall.*
Conclusions *Pregnant farmworkers and those living with farmworkers need to be educated to reduce potential take-home pesticide exposure.* Am. J. Ind. Med. 45:491–499, 2004. *© 2004 Wiley-Liss, Inc.*

KEY WORDS: migrant health; maternal health; farmwork; take-home pesticide exposure

INTRODUCTION

An estimated 3–5 million migrant and seasonal farmworkers, mostly from Mexico, harvest fruits and vegetables in the United States each year [Dever, 1991]. California is home to the largest population of farmworkers in the United States, totaling more than 100,000 with approximately 38,000 farmworkers in the Salinas Valley alone [California Employment Development Department, 2002]. Farmworkers may be exposed to pesticide residues on crops in the fields where they are working or from an application in a neighboring field [National Institute of Occupational Safety and Health (NIOSH), 2000]. In California, about 200 million pounds of pesticidal active ingredient, approximately 25% of the national total, are used on crops annually [California Department of Pesticide Regulation (COPR), 2000].

Family members of farmworkers, who do not work directly in the fields, may also be exposed to pesticides by contamination of the home environment. Farmworkers may inadvertently carry home pesticides on their skin or clothing [Simcox et al., 1995; Bradman et al., 1997; Loewenherz et al., 1997; Fenske et al., 2000; Lu et al., 2000; McCauley et al., 2001]. Studies have found that housedust in home environments of agricultural workers have higher levels of pesticide

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residues than in homes of non-agricultural workers living in similar communities [Simcox et al., 1995; Lu et al., 2000; McCauley et al., 2001] and that the concentration of pesticides in their homes is correlated with the number of farmworkers who reside there [McCauley et al., 2001].

While these studies suggest a take-home pathway for pesticides from work into homes, research identifying specific pathways and interventions to reduce these exposures are limited. Pesticide residues have been measured on farmworker skin (e.g., hands), work clothing, and shoes [Fenske, 1988; Koizumi, 1991; United States Environmental Protection Agency (EPA), 1992; Gomes et al., 1999; Boeniger and Lushniak, 2000; Campbell et al., 2000; Keifer, 2000; Krieger and Dinoff, 2000; Brouwer et al., 2000]. Other studies have evaluated the effectiveness of clothing as a means to reduce dermal loading of pesticides and thus farmworkers' exposures [Nigg et al., 1986; Fenske, 1988; Csiszar et al., 1998; Saleh et al., 1998; Gomes et al., 1999]. Finally, several studies have investigated the efficacy of different laundering methods in removing pesticide residues on work clothes [Grieshop and Stiles, 1994]. These findings have lead to a set of ''common sense'' recommendations (and in some cases regulations) about behaviors that should reduce exposures, such as wearing appropriate clothing in the fields after re-entry periods expire (e.g., long pants and shirts) [United States Environmental Protection Agency (EPA), 1995; California Department of Pesticide Regulation (CDPR), 1999; The Pesticide Management Education Program at Cornell University (PMEP), 2001], changing out of work clothes before entering homes [United States Environmental Protection Agency (EPA), 1995; The Pesticide Management Education Program at Cornell University (PMEP), 2001], and washing work clothes separately from family clothes [United States Environmental Protection Agency (EPA), 1995; Easley et al., 1998; United States Environmental Protection Agency (EPA), 1998; The Pesticide Management Education Program at Cornell University (PMEP), 2001; Whitford et al., 2001].

Several researchers have investigated the frequency of these recommended risk-reducing behaviors. McCauley et al. [2001] studied exposure-related behaviors among 166 agricultural workers in Oregon. In this predominantly male population, 18.1% reported using protective clothing (i.e., a bandana over the mouth or nose, glasses or goggles, sun hat or cap, or coveralls). More than 60% entered their homes wearing their work shoes, and 75% wore work clothing into their homes, with a third changing out of these clothes more than ½ hr after arriving home. Among a group of farmworkers ($n = 383$) in Washington State, approximately half reported that they did not wash their hands immediately after work (51%), did not remove their boots before entering the home (46%), did not remove their work clothes within 1 hr of returning home (45%), or did not bathe within 1 hr of returning home (55%) [Thompson et al., 2003]. However, most workers washed work clothes separately from other clothes (83%) [Thompson et al., 2003].

One of the largest and most comprehensive programs to educate farmworkers on ways to reduce their exposure to pesticides in the United States is the Environmental Protection Agency's (EPA) Worker Protection Standard (WPS) [United States Environmental Protection Agency (EPA), 1992], which went into effect in 1995. All farmworkers who enter areas treated with pesticides must receive pesticide safety training by an EPA qualified trainer using an approved WPS curriculum. While the WPS does not specifically focus on reducing pesticide exposure in the home, the curriculum covers routes through which pesticides enter the body and hazards from pesticide residues on clothing [Arcury et al., 1999]. It is unknown what proportion of farmworkers has actually received this training and whether it has had an impact on farmworkers' behaviors.

Understanding the behaviors of farmworkers and their families, and identifying those who have the riskiest behaviors could inform interventions aimed at reducing pesticide exposure. Because pregnancy may be a time of heightened awareness about health behaviors and thus, when interventions may be most effective, we examined the behaviors of a group of pregnant female residents of the Salinas Valley, who were farmworkers or who lived with farmworkers during pregnancy.

METHODS

Participants

The data for this analysis were collected as part of the CHAMACOS (Center for the Health Assessment of Mothers and Children of Salinas) study, an ongoing prospective birth cohort study of pesticide and allergen exposures to pregnant women and children living in the Salinas Valley, Monterey County, CA. The Salinas Valley is located approximately 100 miles south of San Francisco and is one of the largest vegetable growing areas in the nation.

A total of 601 pregnant women were enrolled from October 1999 through October 2000. Women were eligible for enrollment if they were less than 20 weeks gestation, Medi-Cal eligible, 18 years or older, received prenatal care at one of two community clinics (Clinica de Salud Del Valle de Salinas and Natividad Medical Center), and planned to deliver at the county hospital, Natividad Medical Center. The present analyses were restricted to the 153 women who worked in farmwork during pregnancy and the 248 women who did not work in farmwork but resided with at least one other farmworker. All study procedures received approval from the UC Berkeley and Natividad Medical Center Committees for the Protection of Human Subjects.

Data Collection

Data for these analyses were collected during the baseline interviews conducted at approximately 14 weeks gestation (M ± SD = 13.5 ± 5.2 weeks). This interview, conducted by trained bilingual interviewers using a structured questionnaire, gathered information on sociodemographic characteristics, health behaviors, medical and reproductive history, occupational information, housing characteristics, house cleaning practices, home pesticide use, pets, and behaviors related to potential take-home pesticide exposure of the women and other household members.

Data Analysis

Eight potentially risky behaviors were identified based on their hypothesized association with a woman's or her family's potential exposure to pesticides and included practices around: (1) handwashing in the field before smoking or eating (sometimes or never vs. usually or always); (2) bathing after arriving home from work (less than once a day, before work, more than 30 min after arriving home vs. immediately after arriving home); (3) wearing adequate clothing to protect against pesticide exposure (did not wear a long sleeve shirt, something to cover the head and gloves when working on the fields vs. wore all three); (4) storing and washing of farmworker work clothes (storage and washing together with family clothes vs. separately); (5) frequency of house-cleaning (cleaning home less than a few times per week vs. more[1]); (6) eating of fruits and vegetables directly from the field (ever vs. never); (7) wearing of work shoes from the fields into the house (wearing by any farmworkers in household vs. none); and, (8) wearing of work clothes into the house (wearing by any farmworkers for greater than ½ hr in the house vs. less).

We determined whether the sociodemographic characteristics of those farmworkers who reported risky behaviors differed from those who did not, using chi-square tests. The demographic characteristics we considered included age, total aggregated years of residency in the United States, marital status, language spoken at home, educational level, parity, income, the number of agricultural workers who lived with the woman since pregnancy, the number of total household members, the number of homes the woman lived in since pregnancy, the distance of the home to the nearest field, and whether she was employed by a farm labor contractor.

We also constructed an eight-point scale with one-point given for each of the risky behaviors above. A multiple linear regression model of the 153 pregnant farmworkers was constructed with the score on the scale as the dependent variable. Sociodemographic variables that had a significant relationship with any of the risky behaviors at $P < 0.1$ in the univariate analysis were considered as potential predictors of the composite score. Those variables were analyzed individually in a regression model with the score as the outcome; number of years lived in the United States, and number of household members had *P*-values less than 0.1 and were included in a final multivariate model for the composite risk score. Although parity was not identified as a significant predictor of the composite score, the size of the coefficient as well as importance to the study warranted inclusion in the multivariate analysis. Regression assumptions were checked using residual versus fitted plots, and quantile-quantile plots.

Finally, we compared the household level risk behaviors (i.e., risk factors 4–8 above) between households where the woman was a farmworker (n = 153) and households where the women did not do any agricultural work, but who resided with at least one other farmworker (n = 248). The objective of this secondary aim was to determine whether there were less risky behaviors in households where the respondent herself was a farmworker since she may have received WPS training. We hypothesized that farmworkers who were pregnant might have a greater influence on household level practices than when the pregnant women were not farmworkers.

All analyses were conducted using STATA 7.0 (STATA Corporation, College Station, TX).

RESULTS

The 153 farmworkers averaged 26.1-years-old (SD = 5.4), and were primarily married or living as married (77.1%), Spanish-speaking (98.0%), and multiparous (65.4%) (see Table I). Approximately a third of the population had lived in the United States for less than 1 year, a third for 2–5 years, and a third for 6–10 years. Most lived with four or more people since becoming pregnant (81.7%) and most reported a monthly household income of $2,000 dollars or less (88.6%). Almost all women were living within 200% of the US federal poverty line, which represents an annual income of $17,650 for a family of four [United States Census Bureau, 2000]. Many household members were also agricultural workers; 57.9% of the farmworker women had lived with three or more agricultural workers since becoming pregnant. At the time of interview, more than a quarter of the women reported having lived in two or more homes in the short time since becoming pregnant. Sociodemographic characteristics of the 248 non-farmworker women who lived with farmworkers were similar to the farmworkers except that they lived in the United States longer ($P = 0.002$), and were more likely to be married ($P = 0.04$), and to have completed more than a sixth grade education ($P = 0.004$). Levels of organophosphate urinary metabolites varied widely in the

[1] Women were asked how often they clean their home and given the following options: daily or more often, a few times a week, once a week, once every couple of weeks, once a month or less often. For the purpose of this variable, women who reported cleaning less than a few times a week were compared to women who cleaned a few times a week, daily or more often.

TABLE I. Demographic Characteristics of Pregnant Farmworkers and Non-Farmworkers, CHAMACOS, Salinas, CA 1999–2000

Characteristic	Farmworkers N = 153 n (%)	Non-farmworkers N = 248 n (%)
Age (years)		
18–24	66 (43.1)	129 (52.0)
25–29	53 (34.6)	72 (29.0)
30 or more	34 (22.2)	47 (18.9)
Years in US		
≤1	46 (30.3)	75 (30.4)
2–5	48 (31.6)	67 (27.1)
6–10	41 (27.0)	45 (18.2)
11 or more	17 (11.2)	37 (15.0)
Entire life in US	NA	23 (9.3)
Marital status		
Married	118 (77.1)	210 (85.0)
Not married	35 (22.9)	37 (15.0)
Language spoken at home**		
English	NA	12 (4.9)
Spanish	150 (98.0)	225 (91.1)
Both	3 (2.0)	10 (4.1)
Education**		
≤6th grade	89 (58.2)	104 (41.9)
7–12th grade	50 (32.7)	100 (40.3)
>High school graduate	14 (9.2)	44 (17.7)
Parity		
0	53 (34.6)	89 (35.9)
≥1	100 (65.4)	159 (64.1)
Income		
$750 or less	28 (18.8)	54 (23.6)
$751–1,500	79 (53.0)	114 (49.8)
$1,501–2,000	25 (16.8)	38 (16.6)
$2,001 or more	17 (11.4)	23 (10.0)
Agricultural workers at home***		
0	8 (5.3)[a]	0 (00.0)
1–2	56 (36.8)	152 (61.8)
3–4	49 (32.2)	66 (26.8)
5 or more	39 (25.7)	28 (11.4)
Number of household members		
1–3	28 (18.3)	51 (20.6)
4–5	39 (25.5)	57 (23.0)
6–8	45 (29.4)	77 (31.1)
9 or more	41 (26.8)	63 (25.4)
Maternal work status		
Not working	NA	185 (58.7)
Working, non-agriculture	NA	63 (20.0)
Number of homes lived in since pregnant		
1	109 (73.1)	187 (76.6)
≥2	40 (26.9)	57 (23.4)
Housing distance to field (ft)		
≤200	30 (19.9)	29 (12.2)
>200	121 (80.1)	208 (87.8)
Employed by labor contractor*		
No	87 (56.9)	NA
Yes	66 (43.1)	NA

*$P < 0.05$.
**$P < 0.005$.
***$P < 0.0001$.
[a]Eight women who were farmworkers themselves did not have any other farmworkers living in the home.

population. Median dialkyl phosphate metabolite concentrations were 129.9 nmol/L (inter-quartile range: 63.0–286.7) when each woman's pregnancy measurements were averaged (data not shown). Future analyses will investigate which factors may be associated with these exposures.

As shown in Table II, for most behaviors, a substantial proportion of women reported not taking precautions to prevent pesticide exposure at work or home. For example, at work, 24.8% of the farmworkers reported sometimes or never washing their hands at work before eating or smoking and 32.7% reported not wearing protective clothing. At home, 43.8% washed their work and family clothes together, 30.7% cleaned their homes less than a few times per week, and 32.0 and 45.5% lived in homes where people wore work shoes or work clothes into the home, respectively. In addition, 60.1% of the farmworker women reported eating fruits and vegetables directly from the field. According to the women's report, the households of pregnant farmworkers did not differ from the households of pregnant non-farmworkers in their practices around washing and cleaning, eating produce from the fields, or wearing clothes into the home. However, agricultural workers were less likely to wear their work shoes into the homes where the pregnant woman was a farmworker ($P < 0.05$).

Table III presents frequencies and percentages of pregnant farmworkers who demonstrated risky behaviors by sociodemographic characteristics. Few demographic characteristics described those pregnant farmworkers who engaged in risky behaviors. Women who lived with nine or more household members since becoming pregnant were less likely to wash their hands before eating or smoking at work. Non-married women, nulliparous women, and women living with no other agricultural workers were more likely to live in households where work clothes were stored and washed together with regular clothes. Also, married women were more likely to eat fruits and vegetables directly from the field and nulliparous women were more likely to live in a household where agricultural workers wore their work shoes inside.

TABLE II. Frequencies of Risk Behaviors Among Pregnant Farmworkers, and Non-Farmworkers who Lived With at Least one Other Agricultural Worker, CHAMACOS, Salinas, CA 1999–2000

Characteristic	Farmworkers n = 153 n (%)	Non-farmworkers n = 248 n (%)
Handwashing†		
Sometimes or never	38 (24.8)	NA
Always or usually	115 (75.2)	NA
Bathing†		
Other time	64 (41.8)	NA
Immediately after work	89 (58.2)	NA
Protective clothing†		
Less than all three items	50 (32.7)	NA
Long sleeve shirt, hat, gloves	103 (67.3)	NA
Clothes storage & washing		
Do not store and wash separately	67 (43.8)	151 (47.9)
Store and wash separately	86 (56.2)	164 (52.1)
House cleaning		
Less than a few times a week	47 (30.7)	89 (28.3)
Daily or a few times a week	106 (69.3)	226 (71.7)
Fruits and vegetables from field		
Eat directly from fields	92 (60.1)	175 (55.9)
Do not eat directly from field	61 (39.9)	138 (44.1)
Wear work shoes in house*		
1 or more people	49 (32.0)	133 (42.2)
0 people	104 (68.0)	182 (57.8)
Wear work clothes more than 30 min before changing		
1 or more people	66 (45.5)	143 (49.7)
0 people	79 (54.5)	145 (50.3)

*$P < 0.05$.
†Handwashing, bathing and protective clothing behaviors were only analyzed for those working in the fields.

The composite score comprised of the eight behaviors averaged 3.0 points (SD ± 1.6) on a scale of 0 (least risky) to 8 (most risky). The multivariate analysis indicated that pregnant farmworkers who had lived in the United States for 11 years or more had a higher risk score (i.e., more risky behavior) than women who had lived in the United States for less than 1 year (Table IV). Although not significant, nulliparous women had more risky behavior than multiparous women. Additionally, women who lived with nine or more people since becoming pregnant had higher risk scores than women who lived with one to three household members.

DISCUSSION

The results of this study suggest that many pregnant farmworkers have not adopted behaviors which may minimize pesticide exposure to themselves or their families. In fact, except for fewer farmworkers wearing work shoes into the home, households with pregnant farmworkers did not report taking any extra precautions to prevent pesticide exposure compared to households with pregnant women who are not farmworkers. Women who have been in the United States for a longer time, and women who lived with more people had more risky behaviors overall.

We do not know whether these pregnant farmworkers had received pesticide safety training. Although EPA's WPS is designed to reach all farmworkers, preliminary data from our Center in a different study population from the same region, suggest that many farmworkers in the area are not receiving pesticide safety training [Salvatore, 2003]. Data from North Carolina also suggest that few farmworkers receive adequate training [Arcury et al., 1999]. Additionally, WPS training does not specifically address important behaviors that could affect take-home exposures such as house cleaning and the importance of changing out of work clothes and removing work shoes upon arriving home.

Our results are similar to those from North Carolina, Oregon, and Washington, which also demonstrate that a significant percentage of workers are not adopting pesticide safety behaviors. Compared to 270 male farmworkers in North Carolina, we report a smaller percent who wore sufficient protective clothing (24.8% vs. 56.9%) [Arcury et al., 1999]. However, in comparison to a study of 166 male and female farmworkers in Oregon [McCauley et al., 2001], a higher proportion of farmworkers in our study reported not changing out of work clothes within 30 min after arriving home (45.5% vs. 33.3%), although similar proportions (about a third) wore work shoes in the house [McCauley et al., 2001]. Similarly, in comparison to a study of 383 male and female farmworkers from Washington, a much higher proportion of farmworkers in our study did not wash their work clothes separately from their family clothes (43.8% vs. 17.%), although somewhat more women in our study showered immediately after work (58.2% vs. 45.4%) [Thompson et al., 2003]. Overall, in comparing our data to those from North Carolina, Oregon, and Washington, our results suggest that pregnant women are not taking any extra precautions to protect themselves from pesticide exposure at work and/or at home, in spite of the potential additional risk to the fetus.

The results of this study suggest that interventions should be implemented with farmworkers and their families to reduce behaviors potentially associated with pesticide exposures. We also found that certain subgroups may be at higher risk for pesticide exposure, suggesting the need for more targeted interventions. For example, women who have lived in the United States longer were less likely to take precautions to prevent pesticide exposure. This finding is similar to results of other studies demonstrating higher rates of risky behaviors, such as smoking and alcohol consumption, in acculturated pregnant Latinas [Guendelman et al., 1990; English et al., 1997]. Another population that may be at

TABLE III. Frequencies and Percentages of Pregnant Farmworkers (n = 153) Demonstrating Risky Behavior by Sociodemographic Characteristics, CHAMACOS, Salinas, CA 1999–2000

Characteristic	Total N	Sometimes/never washing hands before eating or smoking n (%)[a]	Not bathing immediately after work n (%)	Not wearing at least a long sleeve shirt, hat, and gloves n (%)	Not washing and storing work clothes separate n (%)	Cleaning house less than a few times a week n (%)	Eating fruits & vegetables directly from field n (%)	1 or more wearing work shoes in home n (%)	1 or more wear work clothes more than 30 min n (%)
Age (years)									
18–24	66	18 (27.3)	30 (45.4)	43 (65.2)	32 (48.5)	18 (27.3)	42 (63.6)	51 (22.7)	29 (44.6)
25–29	53	11 (20.8)	21 (39.6)	38 (71.7)	22 (41.5)	16 (30.2)	30 (56.6)	32 (60.4)	24 (50.0)
30 and more	34	9 (26.5)	13 (38.2)	22 (64.7)	13 (38.2)	13 (38.2)	20 (58.8)	21 (61.8)***	13 (40.6)
Total years in US									
≤1	46	11 (23.9)	18 (39.1)	33 (71.7)	21 (45.7)	13 (28.3)	27 (58.7)	37 (80.4)	20 (45.5)
2–5	48	10 (20.8)	22 (45.8)	35 (79.9)	20 (41.7)	14 (29.2)	29 (60.4)	30 (62.5)	17 (37.8)
6–10	41	10 (24.4)	18 (43.9)	28 (68.3)	16 (39.0)	11 (26.8)	27 (65.8)	26 (63.4)	21 (53.8)
11 or more	17	6 (35.3)	6 (35.3)	7 (41.2)***	9 (52.9)	9 (52.9)	8 (47.1)	10 (58.8)	8 (50.0)
Marital status									
Married	118	27 (22.9)	47 (39.8)	75 (63.6)	45 (38.1)	35 (29.7)	76 (64.4)	84 (71.2)	53 (46.9)
Not married	35	11 (31.4)	17 (48.6)	28 (80.0)***	22 (62.9)*	12 (34.3)	16 (45.7)**	20 (57.1)	13 (40.6)
Language at home									
Spanish	150	38 (25.3)	63 (42.0)	102 (68.0)	67 (44.7)	47 (31.3)	90 (60.0)	101 (67.3)	64 (45.1)
Other	3	0 (0.00)	1 (33.3)	1 (33.3)	0 (0.00)	0 (0.00)	2 (66.7)	3 (100)	2 (66.7)
Education									
≤6th grade	89	18 (20.2)	34 (38.2)	65 (73.0)	41 (46.1)	28 (31.5)	54 (60.7)	61 (68.5)	35 (42.7)
7–12th grade	50	16 (32.0)	24 (48.0)	28 (56.0)	2 (44.0)	15 (30.0)	29 (58.0)	36 (72.0)	23 (46.9)
≥High school	14	4 (28.6)	6 (42.9)	10 (71.4)	4 (28.6)	4 (28.6)	9 (64.3)	7 (50.0)	8 (57.1)
Parity									
0	53	16 (30.2)	26 (49.1)	35 (66.0)	32 (60.4)	13 (24.5)	35 (66.0)	44 (83.0)	24 (46.2)
≥1	100	22 (22.0)	38 (38.0)	68 (68.0)	35 (35.0)*	34 (34.0)	57 (57.0)	60 (60.0)*	42 (45.2)
Monthly income									
$750 or less	28	8 (28.6)	12 (42.9)	19 (67.9)	16 (57.1)	10 (35.7)	13 (46.4)	17 (60.7)	11 (45.8)
$751–1,500	79	20 (25.3)	34 (43.0)	58 (73.4)	33 (41.8)	28 (35.4)	44 (55.7)	55 (69.6)	37 (47.4)
$1,501–2,000	25	7 (28.0)	8 (32.0)	12 (48.0)	11 (44.0)	4 (16.0)	20 (80.0)	16 (64.0)	9 (39.1)
$2,001 or more	17	3 (17.6)	10 (58.8)	10 (58.8)	5 (29.4)	3 (17.6)	11 (64.7)***	13 (76.5)	7 (43.7)
Agricultural workers in home, n									
0	8	3 (37.5)	3 (37.5)	3 (37.5)	7 (87.5)	2 (25.0)	4 (50.0)	5 (62.5)	2 (40.0)
1–2	56	14 (25.0)	25 (44.6)	39 (69.6)	24 (42.9)	19 (33.9)	32 (57.1)	32 (57.1)	24 (46.2)
3–4	49	9 (18.4)	23 (46.9)	34 (69.4)	16 (32.7)	15 (30.6)	29 (59.2)	35 (71.4)	21 (42.9)
5 or more	39	11 (28.1)	13 (33.3)	26 (66.7)	19 (48.3)**	11 (28.2)	26 (66.7)	31 (79.5)	19 (50.0)

Household members, n										
1–3	28	6 (21.4)	9 (32.1)	18 (64.3)	9 (32.1)	13 (46.4)	15 (53.6)	8 (28.6)	13 (56.6)
4–5	39	6 (15.4)	18 (46.2)	26 (66.7)	20 (51.3)	11 (28.2)	24 (61.5)	14 (35.9)	18 (46.2)
6–8	45	9 (20.0)	17 (37.8)	32 (71.1)	15 (33.3)	11 (24.4)	26 (57.8)	11 (24.4)	28 (65.1)
9 or more	41	17 (41.5)**	20 (48.8)	27 (65.9)	23 (56.1)***	12 (29.3)	27 (65.8)	16 (39.0)	20 (50.0)
Homes lived in, n									
1	109	26 (23.9)	44 (40.4)	72 (66.1)	41 (37.6)	36 (33.0)	66 (60.6)	35 (32.1)	58 (56.3)
2 or more	40	12 (30.0)	18 (45.0)	28 (70.0)	22 (55.0)***	8 (20.0)	24 (60.0)	14 (35.0)	19 (50.0)
House distance to field (feet)									
≤200	30	4 (13.3)	9 (30.0)	21 (70.0)	14 (46.7)	9 (30.0)	17 (56.7)	12 (40.0)	13 (50.0)
>200	121	34 (28.1)***	54 (44.6)	81 (66.9)	51 (42.2)	37 (30.6)	73 (60.3)	36 (29.8)	64 (54.7)
Labor contractor job									
No	87	22 (25.3)	38 (43.7)	58 (66.7)	35 (40.2)	27 (31.0)	56 (64.4)	26 (29.9)	50 (58.8)
Yes	66	16 (24.2)	26 (39.4)	45 (68.2)	32 (48.5)	20 (30.3)	36 (54.6)	23 (34.8)	29 (48.3)

*$P \leq 0.01$.
**$P \leq 0.05$.
***$P \leq 0.10$.
[a]Row percent; percentages represent the proportion in that sociodemographic stratum who are demonstrating the risk behavior. *P*-values represent comparisons of sociodemographic characteristics with those who did not demonstrate risky behavior, for example 27.3% of farmworkers 18–24 reported sometimes or never washing their hands before eating or smoking while working.

TABLE IV. Multiple Regression Coefficients for the Composite Score for Pregnant Farmworkers, CHAMACOS, Salinas, CA, 1999–2000 (n = 147)

Characteristic	β-coefficient	(95% CI)
Total years lived in the US		
≤1	Referent	
2–5	0.17	(−0.49, 0.82)
6–10	0.40	(−0.31, 1.10)
11 or more	1.07*	(0.15, 2.00)
Parity		
0	Referent	
≥1	−0.25	(−0.81, 0.31)
Household members, n		
1–3	Referent	
4–5	0.47	(−0.31, 1.20)
6–8	−0.13	(−0.90, 0.63)
9 or more	0.86*	(0.07, 1.60)

*$P < 0.05$.

greater risk is women who live in crowded households. Our findings suggest that when women live in crowded conditions, it is more difficult to follow recommendations to reduce take-home exposures, possibly because they have less control over the behaviors of other household members. Additionally, women with children were less likely to engage in risky behavior. Although not a significant relationship, this trend suggests that having children may be an important motive for behavioral change and that pregnancy may be an opportune time to intervene. For example, in the CHAMACOS community, where pregnant farmworkers are likely to receive government subsidized prenatal care, pesticide safety education, which would aim to increase awareness of pesticide safety at work and in the home, could be incorporated into existing prenatal care education programs.

The results of this study may not be generalizeable to other farmworker populations in the United States. The CHAMACOS cohort represents a less mobile farmworker population, in part, because of the opportunities for year-round agricultural employment in the Salinas Valley. Furthermore, all participants were pregnant women, whereas only 20% of farmworkers are women nationwide [Mehta et al., 2000], and even fewer are pregnant. Other study limitations included the possible inaccurate representation of behaviors due to self-reported questionnaire data. More farmworkers may have reported that they take precautions to protect themselves from pesticide exposure than actually do, resulting in an overestimation of the frequency of safety behaviors. Lastly, although all eight behaviors included are hypothesized to be associated with exposure, a causal relationship has not been established in all cases. Further analyses are being conducted with the CHAMACOS cohort to establish this relationship.

Our findings, which are similar to results of other studies [Arcury et al., 1999; McCauley et al., 2001; Thompson et al., 2003], suggest that the majority of pregnant farmworker women in the CHAMACOS cohort are not taking steps that could prevent pesticide exposures to themselves and their families. These findings indicate that additional worker education is necessary to reduce the possibility of take-home exposures. A growing number of researchers are applying community-based, participatory research methods to identify effective intervention strategies that are tailored to the characteristics and needs of a specific community [Elden and Levin, 1991; Israel et al., 1998; Minkler and Wallerstein, 2003; Schulz et al., 2001]. New studies utilizing these methods should be conducted with farmworking women to obtain a clearer understanding of the obstacles to compliance with pesticide exposure-reduction guidelines and possible strategies for overcoming them.

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REFERENCES

Arcury TA, Quandt SA, Austin CK, Preisser J, Cabrera LF. 1999. Implementation of EPA's Worker Protection Standard training for agricultural laborers: An evaluation using North Carolina data. Public Health Rep 114:459–468.

Boeniger MF, Lushniak BD. 2000. Exposure and absorption of hazardous materials through the skin. Int J Occup Environ Health 6:148–150.

Bradman MA, Harnly ME, Draper W, Seidel S, Teran S, Wakeham D, Neutra R. 1997. Pesticide exposures to children from California's Central Valley: Results of a pilot study. J Expo Anal Environ Epidemiol 7:217–234.

Brouwer DH, Boeniger MF, Hemmen JV. 2000. Hand wash and manual skin wipes. Brit Occup Hyg Soc 44(7):501–510.

California Department of Pesticide Regulation. 2000. Summary of Pesticide Use Report Data 1999: Indexed by Chemical: Preliminary Data: CDPR.

California Department of Pesticide Regulation (CDPR). 1999. Manual of Procedural Guidelines for Pesticide Enforcement Personnel. p 115–140.

California Employment Development Department. 2002. County Snapshot: Monterey 2002. Available at http://www.calmis.ca.gov/file/COsnaps/montesnap.pdf

Campbell JL, Smith MA, Eiteman MA, Williams PL, Boeniger MF. 2000. Comparison of solvents for removing pesticides from skin using an in vitro porcine model. Aihaj 61:82–88.

Csiszar E, Borsa J, Racz I, Obendorf SK. 1998. Reduction in human exposure to pesticide using traditional work clothing fabrics with chemical finishing: Carboxymethylation and starch. Arch Environ Contam Toxicol 35:129–134.

Dever G. 1991. Profile of a population with complex health problems Austin, TX: Migrant Clinicians Network, Monograph Series. National Migrant Resource Program.

Easley CB, Laughlin J, Gold R. 1998. Laundering pesticide contaminated clothing, Vol. 2003. Lincoln, NE: University of Nebraska, Lincoln.

Elden M, Levin M. 1991. Cogenerative learning: Bringing participation into action research. In: Whyte W, editor. Participatory action research. Newbury Park, CA: Sage. pp 127–142.

English P, Kharrazi M, Guendelman S. 1997. Pregnancy outcomes and risk factors in Mexican Americans: The effect of language use and mother's birthplace. Ethn Dis 7:229–240.

Fenske RA. 1988. Comparative assessment of protective clothing performance by measurement of dermal exposure during pesticide applications. Appl Ind Hyg 3:207.

Fenske RA, Lu C, Simcox NJ, Loewenherz C, Touchstone J, Moate TF, Allen EH, Kissel JC. 2000. Strategies for assessing children's organophosphorus pesticide exposures in agricultural communities. J Expo Anal Environ Epidemiol 10:662–671.

Gomes J, Lloyd OL, Revitt DM. 1999. The influence of personal protection, environmental hygiene and exposure to pesticides on the health of immigrant farm workers in a desert country. Int Arch Occup Environ Health 72:40–45.

Grieshop JVN, Stiles M. 1994. Wash day blues: Secondhand exposure to agricultural chemicals. J Rural Health 10:247–257.

Guendelman S, Gould J, Hudes M, Eskenazi B. 1990. Generational differences in perinatal health among the Mexican American population: Findings from HHANES 1982–1984. Am J Public Health 80: 61–65.

Israel BA, Schulz AJ, Parker EA, Becker AB. 1998. Review of community-based research: Assessing partnership approaches to improve public health. Annul Rev Public Health 19:173–202.

Keifer MC. 2000. Effectiveness of interventions in reducing pesticide overexposure and poisonings. Am J Prev Med 18:80–89.

Koizumi A. 1991. Experimental evidence for the possible exposure of workers to hexachlorobenzene by skin contamination. Br J Ind Med 48:622–628.

Krieger RI, Dinoff TM. 2000. Malathion deposition, metabolite clearance, and cholinesterase status of date dusters and harvesters in California. Arch Environ Contam Toxicol 38:546–553.

Loewenherz C, Fenske RA, Simcox NJ, Bellamy G, Kalman D. 1997. Biological monitoring of organophosphorus pesticide exposure among children of agricultural workers in central Washington State. Environ Health Perspect 105:1344–1353.

Lu C, Fenske RA, Simcox NJ, Kalman D. 2000. Pesticide exposure of children in an agricultural community: Evidence of household proximity to farmland and take home exposure pathways. Environ Res 84: 290–302.

McCauley LA, Lasarev MR, Higgins G, Rothlein J, Muniz J, Ebbert C, Phillips J. 2001. Work characteristics and pesticide exposures among migrant agricultural families: A community-based research approach. Environ Health Perspect 109:533–538.

Mehta K, Grabbard S, Barrat V, Lewis M, Carroll D, Mines R. 2000. Findings from the National Agricultural Workers Survey (NAWS) 1997–1998, A Demographic and Employment Profile of United States Farmworkers: US Department of Labor, Office of the Assistant Secretary for Policy, Office of Program Economics.

Minkler M, Wallerstein N. 2003. Introduction to community based participatory research. In: Minkler M, Wallerstein N, editors. Community

based participatory research for health. San Francisco: Jossey-Bass. p 3–26.

National Institute of Occupational Safety and Health (NIOSH). 2000. SENSOR Annual Report 2000: NIOSH.

Nigg HN, Stamper JH, Queen RM. 1986. Dicofol exposure to Florida citrus applicators: Effects of protective clothing. Arch Environ Contam Toxicol 15:121–134.

Saleh MA, Kamel A, el-Demerdash A, Jones J. 1998. Penetration of household insecticides through different types of textile fabrics. Chemosphere 36:1543–1552.

Salvatore A, Vasques D, Stamm N, Camacho J, Vargas A, Kavanaugh-Baird G, Lopez J, Bradman A, Eskenazi B. 2003. A field-based technical intervention to reduce pesticide exposure to farmworkers' children. Presented at APHA, San Francisco, CA.

Schulz A, Israel BA, Parker EA, Lockett M, Hill Y, Wills R. 2001. Community based participatory research: Integrating research with action to reduce health disparities. Public Health Reports 116(6):548–557.

Simcox NJ, Fenske RA, Wolz SA, Lee IC, Kalman DA. 1995. Pesticides in household dust and soil: Exposure pathways for children of agricultural families. Environ Health Perspect 103:1126–1134.

The Pesticide Management Education Program at Cornell University (PMEP). 2001. Pesticide Applicator Core Tutorial: Module 8, Personal Protection for the Applicator and Worker.

Thompson B, Coronado G, Grossman J, Puschel K, Solomon C, Islas I, Curl C, Shirai J, Kissel J, Fenske R. 2003. Pesticide take-home pathway among children of agricultural workers: Study design, methods, and baseline findings. J Occup Environ Med 45:42–53.

United States Census Bureau. 2000. Poverty Thresholds in 2000 by size of family and number of related children under 18.

United States Environmental Protection Agency (EPA). 1992. Pesticide Worker Protection Standard Training. 40CFR.

United States Environmental Protection Agency (EPA). 1995. Steps to protect yourself from pesticides (Spanish). Prevention, pesticides and toxic substances (7506C). EPA 735-F-95-002.

United States Environmental Protection Agency (EPA). 1998. Pesticides and Child Safety, Vol. 2003.

Whitford F, Edwards CF, Neal JJ, Martin AG, Osmun J, Hollingworth RM, Blessing A. 2001. Pesticides and personal safety. Purdue University, West Lafayette: Purdue University Cooperative Extension Services.