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Pesticides in the Homes of Farmworkers: Latino Mothers' Perceptions of Risk to Their Children's Health

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Pesticide exposure has been linked with immediate and delayed health effects. Anyone who lives in a farmworker household may be exposed to pesticides. Studies with farmworkers have found generally low levels of awareness of pesticide exposure and prevention. Less is known about the perceptions of nonfarmworkers living with farmworkers. This article presents the results of 41 in-depth interviews conducted with Latino women in farmworker households regarding their knowledge of pesticides and perceptions of risk to their children's health. Their perceptions and behavior differ from scientific understanding and policy recommendations for exposure management, resulting in behaviors that may increase children's risk of exposure and subsequent health problems. Because the level at which exposure becomes harmful remains a subject of scientific debate, the wisest course of action is to minimize exposure (the precautionary principle). Families living in farmworker households would benefit from health education programs that target their specific needs.

Keywords: *pesticide exposure; risk perception; farmworker families; precautionary principle*

The health hazard posed by pesticide exposure is a well-established occupational risk of agricultural work (Arcury & Quandt, 1998b; Reeves & Schafer, 2004). Nonfarmworkers, including children, living in farmworker households are also at risk

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for pesticide exposure and the ensuing health problems (Bradman et al., 1997; Eskenazi, Bradman, & Castorina, 1999; Faustman, Silbernagel, Fenske, Burbacher, & Ponce, 2000; Fear, Roman, Reeves, & Pannett, 1998; Fenske, Kissel, et al., 2000; Fenske, Lu, et al., 2000; Quandt, Arcury, Rao, et al., 2004). Although efforts have been made to require pesticide safety education for workers in the fields (United States Environmental Protection Agency, 1992), much less attention has been paid to educating the wives and partners of farmworkers. These individuals are the most likely to be responsible for protecting the health of their children, yet little is known about their knowledge of pesticides and their perceptions of the risks posed by exposure. This article describes the beliefs and practices of Latino mothers in farmworker households regarding pesticide safety in the home and assesses the need for educational intervention. The findings illustrate the need for more pesticide safety information and education directed specifically to women in this population.

Anyone who lives in a farmworker household, regardless of whether he or she works in the fields, may be exposed to pesticides through a variety of pathways (Fenske, Lu, et al., 2000). Pesticides can drift into yards or through open windows during applications in nearby fields. Workers can carry home residues on their skin, clothing, boots, tools, or vehicles that can be transferred to surfaces in the home or to other individuals. Children might play near or in treated fields. The accumulation of these frequent, low-level exposures can have serious consequences for the health of every member of the household (Eskenazi et al., 1999). The threat to health posed by pesticides and other environmental toxicants is generally considered to be greater for children than for adults because of their small body mass and state of rapid physical and cognitive development (Weiss, Amler, & Amler, 2004). Protection of children's health demands special attention and may require the development of new strategies and techniques for assessing health risks and monitoring and managing exposure (Eskenazi et al., 1999; Faustman et al., 2000; Landrigan, Kimmel, Correa, & Eskenazi, 2004; Zahm & Ward, 1998).

PESTICIDE EXPOSURE

An Environmental Health Issue

Exposure to pesticides, whether acute or chronic, is an environmental health threat with wide-ranging, long-term implications. At the individual level, acute injuries from spills or accidental ingestion can have health impacts ranging from skin and eye injuries to systemic poisoning and death (Reigart & Roberts, 1999). Chronic exposure to low levels of pesticides or their residues (invisible active ingredients that persist on surfaces after the chemical has evaporated) on plants has been linked with serious health problems such as cancer, birth defects, infertility, and neuropsychological deficits (Baldi et al., 2001; Garry et al., 2002; Oliva, Spira, & Multigner, 2001; Savitz, Arbuckle, Kaczor, & Curtis, 1997; Zahm & Ward, 1998; Zheng et al., 2001). On a larger scale, agricultural pesticides have been implicated in groundwater pollution, an environmental health hazard that will affect workers and nonworkers alike well into the future (Tucker & Napier, 1998).

During the past 15 years, farmwork in the United States has increasingly been performed by immigrants from Mexico or other Latin American countries who usually have low incomes and have limited literacy and English proficiency (Mehta et al., 2000). They often live in poor-quality housing located in lower income, isolated areas with

inadequate health care facilities and seldom have health insurance. The socioeconomic hardships faced by farmworkers in the United States contribute to a variety of concerns, such as food insecurity (Quandt, Arcury, Early, Tapia, & Davis, 2004), that have both short- and long-term health implications. As a result, they usually have poorer health than the general population (Austin et al., 2002; Villarejo, 2003).

The poor quality of farmworker housing increases the likelihood of exposure to residential pesticides, and its location on or near farms increases the likelihood of drift. Studies in California (Mills & Zahm, 2001) detected pesticides in dust samples taken from farmworker family housing and in hand wipe samples taken from children living in those homes (Bradman et al., 1997). Ongoing studies in Washington State (Curl et al., 2002; Lu, Fenske, Simcox, & Kalman, 2000; Thompson et al., 2003) are finding concentrations of pesticides that were higher in farmworker homes than in nonagricultural reference homes, as were the urinary metabolite levels in farmworker children versus nonfarmworker children (Fenske, Kissel, et al., 2000). Residues in house dust in an Oregon study were associated with residential density in farmworker housing as well as distance to fields and raised concerns about children's play behaviors as an exposure route (McCauley et al., 2001). Research in North Carolina corroborates these findings, with residues of either agricultural or residential pesticides found in 39 of 41 houses tested (Quandt, Arcury, Early, et al., 2004). In all the studies, proximity to fields was associated with greater likelihood of the presence of agricultural pesticide residues indoors. Housing is a significant pesticide exposure pathway for farmworker children.

The Precautionary Principle

Although studies such as those cited above demonstrate an association between pesticide exposure and health effects, the question of how much exposure over what period of time will lead to those outcomes has yet to be answered, especially for children (Brent & Weitzman, 2004; Weiss et al., 2004). Other factors that may also affect the long-term impact of exposure, such as age at first exposure and exposure route, have not been studied. Lengthy latent periods between exposure and postulated outcomes make impossible the determination of a pesticide dose that can be deemed "safe" (Arcury & Quandt, 1998a). The need to maximize agricultural output while at the same time protecting human health leads to considerable debate about appropriate risk management with regard to pesticides. These circumstances, combined with the potential severity and irreversibility of the outcomes, warrant observing the "precautionary principle." The precautionary principle states that in the absence of scientific certainty about the likelihood and severity of harm from a given health threat, a cautious approach to risk management is appropriate and perhaps obligatory (Gollier & Treich, 2003; Grandjean, 2004). In this case, the given health threat is exposure to pesticides. Although scientific evidence unequivocally demonstrating negative health effects from pesticide exposure does not yet exist, enough is known about the potential risks to warrant a defensive position. Until proven otherwise, exposure to pesticides should be considered a significant health risk to be actively avoided.

The precautionary principle is most commonly invoked at the policy level, but its effectiveness requires input at the individual level as well (Nelkin, 2003). For that to happen, members of a population at risk for a given health threat need to be aware of the potential threat, perceive themselves to be at risk for negative effects as a result of exposure to it, and believe they have some control over preventing those negative effects from occurring (Baranowski, Perry, & Parcel, 2002; Janz, Champion, & Strecher,

2002). The existence of these factors (awareness of threat, perception of risk, belief in controllability) are influenced more by the sociocultural and political environment than they are by scientific evidence (Nelkin, 2003). Their absence within socially and politically vulnerable groups can exacerbate health disparities and lessen the effectiveness of educational campaigns and other interventions (Miller & Solomon, 2003; Nichter, 2003; Oaks & Harthorn, 2003).

Perceptions of Risk

Studies have documented the perceptions of various agricultural stakeholders about pesticide exposure. Interviews with growers in North Carolina revealed that pesticide exposure is not perceived by growers to be a problem for hired workers because those workers do not apply pesticides, and they do not enter treated fields until the reentry interval has expired (Quandt, Arcury, Austin, & Saavedra, 1998; Rao, Arcury, Quandt, & Doran, 2004). Research in Washington State yielded similar results, including lower levels of compliance with the US-EPA Worker Protection Standard for field workers than for handlers (those who mix, transport, or apply pesticides) (Thompson et al., 2003).

Studies with farmworkers show more mixed results. Perceptions of risk from exposure among Mexican farmworkers in California were found to be highest among those who believed that harm from pesticides had occurred in the past and was likely to occur in the future and that exposure to pesticides was unavoidable (Vaughan, 1993). Those who felt they had some amount of control over their health and believed that preventive measures were effective were more likely to take steps to protect themselves and their children. In a later study in the same area, these perceptions were found to vary with socioeconomic status. Individuals of lower socioeconomic status believed that they were at greater risk of harm while simultaneously having less control over avoiding it (Vaughan, 1995). A study comparing locus of injury control between farmworkers and farmers in California revealed that workers felt that control over workplace safety was external (outside themselves), whereas farmers felt it was internal (Grieshop, Stiles, & Villanueva, 1996). Workers were more likely to feel that workplace safety was in the hands of God, luck, or their bosses, whereas farmers were more confident in their own ability to control and manage workplace safety. Adolescent Latino farmworkers in Oregon were aware that pesticides can cause health problems, but fewer than half believed it was possible to protect themselves from pesticides. Pesticide sickness was considered an unavoidable consequence of the work, although "weaker" individuals were thought to be more vulnerable (Salazar, Napolitano, Scherer, & McCauley, 2004). Nonetheless, these teenagers were generally optimistic that they personally would not suffer health effects in the future (McCauley, Sticker, Bryan, Lasarev, & Scherer, 2002).

Farmworkers in North Carolina stated that pesticides were dangerous only for the weeds or insects they were intended to kill. Others felt that although pesticides may be harmful to human health, the danger was primarily from acute exposure; furthermore, their employers would not expose them to something harmful (Quandt et al., 1998). In related research, a substantial proportion (20% to 30%) of farmworker participants responded that pesticides did not pose a significant health risk to themselves or their children (Arcury, Quandt, & Russell, 2002).

Two studies conducted in California specifically addressed women's perceptions of pesticide exposure (Goldman, Eskenazi, Bradman, & Jewell, 2004; Harthorn, 2003). One study assessed perceptions of pesticide exposure, pathways, and health effects of 10 female farmworkers using qualitative methods (Harthorn, 2003). The other used survey

and interview data to compare risk behaviors between 153 women who worked in the fields while pregnant and 248 women who lived in farmworker households but did not work in the fields (Goldman et al., 2004). In the smaller study, workers varied in their knowledge and understanding of pesticide exposure. Most were aware of the hazards posed by exposure but did not consider themselves to be at serious risk. They considered the smell of chemicals to be evidence of exposure, especially if it caused nausea. The larger study found no difference in risk behaviors between the two groups. *Safety recommendations regarding pesticide exposure* were known in general terms but adhered to only intermittently. Female workers in both studies voiced general concerns about possible negative effects during pregnancy and on their children's health from pesticide exposure. Although the samples in both studies limit their generalizability to female farmworkers in a single region of the country, they nonetheless confirmed the need to provide safety information to family members other than the field worker.

In summary, most research on perceptions of pesticide exposure reported to date has been conducted with male farmworkers and other stakeholders who are directly involved with agriculture. These studies reveal little about perceptions of risk among nonfarmworker individuals, especially women's perceptions of their children's risk. Given the potential severity of pesticide exposure outcomes and the strong evidence for the presence of pesticides in farmworker housing, more direct action must be taken to inform nonfarmworkers in farmworker households about the potential dangers of pesticide exposure. An effective intervention must be based on an understanding of the state of the knowledge and awareness of the issue among those who are in the position to motivate change. This article presents results from a study in North Carolina to assess the knowledge, perceptions, and behaviors of mothers in farmworker households regarding their family's exposure to pesticides as the preliminary stage in developing culturally appropriate and meaningful educational programs.

REDUCING FARMWORKER PESTICIDE EXPOSURE IN NORTH CAROLINA: THE ¡LA FAMILIA! PROJECT

Overview

The data in this analysis were collected in the research phase of *¡La Familia! Reducing Farmworker Pesticide Exposure*, a community-based participatory project to develop and evaluate a culturally appropriate program to reduce residential pesticide exposure among farmworker families. The research was conducted in five mountain counties in northwest North Carolina (Alleghany, Ashe, Avery, Mitchell, Watauga) and three in southwest Virginia (Smyth, Grayson, Carroll). The agriculture in this region is dominated by the production of Christmas trees, ornamental plants and burley tobacco, with some vegetables (e.g., cabbage, green beans) and fruits (e.g., apples) being produced. An array of insecticides, herbicides, and fungicides are used in mountain agriculture (Cope, Avery, Storm, & Luginbuhl, 1998, 1999a, 1999b). Christmas trees have become the dominant agricultural commodity, with total sales of more than \$100 million per year. Christmas trees are produced by large and small growers; two thirds of the state's 1,500 producers operate on less than 10 acres (North Carolina Cooperative Extension, 1999). As is the case in other parts of the Southeast and the nation (Mehta et al., 2000; Mines, Gabbard, & Steirman, 1997), the majority of farmworkers in these

counties are Latino immigrants, and most of the Latino farmworkers are from Mexico (Arcury et al., 2002; Quandt, Preisser, & Arcury, 2002). Many Latino women in the area also work seasonally, making Christmas garlands and wreaths.

Sampling Strategy

Eligible households consisted of at least one adult who worked in agriculture and a mother with at least one child under the age of 7 years. Agricultural work was defined to include work in Christmas trees, field crops, nurseries, and Christmas wreath and garland production. The mother was interviewed in all households; in a small subset of households, other family members also participated. Potentially eligible households were located using a site-based sampling strategy at locations where members of farmworker families were likely to be found (Arcury & Quandt, 1999). Sites included women's groups sponsored by county Cooperative Extension Services and Partnerships for Children; English as a second language (ESL) and high school equivalency (GED) classes; and health and social service agencies, such as migrant health programs, county health departments, and Women, Infants, Children (WIC) offices. Additional participants were located by asking participants if they knew of any eligible families that might be willing to be interviewed. Sampling by referral, or snowball sampling, is a common technique for locating members of difficult-to-reach populations (Bernard, 2002).

Data Collection

Interviews were conducted in the participants' homes when at least one child in the target age range was home. Before beginning data collection, informed consent was obtained in accordance with the requirements of the Institutional Review Boards of Wake Forest University School of Medicine and the Centers for Disease Control and Prevention.

Topics covered in the in-depth interview included general family background information, migration history, and health status; work histories and pesticide experience of the mother and her partner or other farmworkers living in the house; and knowledge of pesticide exposure and its prevention and effects. The interviews were conducted in Spanish, recorded on tape, and lasted between 30 minutes and 2 hours depending on the participant's interest level, her conversational style, and the number of interruptions.

Data Analysis

The 41 in-depth interviews were transcribed and translated into English by a professional translation service. Transcripts were reviewed by Spanish-speaking members of the research team throughout the data entry and analysis process. Questions regarding accuracy of translations were addressed prior to analysis by referring to the original transcript (or tape if necessary). The transcripts were managed using *The Ethnograph*, v5.0 (Seidel, 1998), a computer program for text-based data analysis. A coding scheme was developed based on the in-depth interview guide. Each transcript was reviewed and coded by members of the research team to identify overarching themes, patterns, and issues in the narratives (Luborsky, 1994). Interviews were coded by one member of the team and reviewed by a second to ensure consistency. Results for each code were summarized in order to obtain an overall picture of the participants' perceptions of their own and their families' risk of pesticide exposure, including the likelihood, danger, and control of that exposure.

Perceptions of risk identified in the interviews are structured using a cognitive models framework that adapts the constructs of cultural models (Holland & Quinn, 1987) and explanatory models of illness (Kleinman, 1980). The premise underlying *cultural models* is that individuals organize their beliefs, perceptions, and knowledge about the world into mental “templates” that are shared, albeit imperfectly, by members of a culture regarding a given domain of information. These templates guide individuals in taking culturally appropriate decisions and actions, as well as in assessing and interpreting those of others. *Explanatory Models of Illness* is a framework for developing cultural models of specific disease processes. Analytic categories include disease-specific features such as cause, symptoms, risk, effects, and treatment. Since pesticide exposure as a domain includes topics and concepts not normally included in an explanatory models framework (e.g., training, work experience), the analytic categories have been modified in this study. They include *overall awareness and salience* of the risk of pesticide exposure; *experience, education, information* related to pesticides; beliefs about pesticide *exposure, protection, and risk*; beliefs and knowledge of the *effects, symptoms, and severity* of pesticide exposure; *treatment* of pesticide-related illness; and behaviors for *managing* pesticide exposure. Illustrative quotations from the participants are presented, followed by participant age in parentheses.

RESULTS

The 41 families in the study were mostly from Mexico, with one family each from Guatemala, Honduras, and Peru. The women’s ages ranged from 18 to 45 years. Each had between one and six children living with her, ranging in age between newborn and 16 years. The quality of their housing covered a broad spectrum, from fairly new split-level homes to converted farm outbuildings, trailers, and dilapidated farm houses. All women were either married or living as married. In most households, all the farmworkers were male. In a few, the mother also worked seasonally in nurseries or in tobacco, usually during harvest and other high-labor demand seasons. The most common occupational activity of the women relevant to pesticide exposure was making Christmas wreaths and garlands using clippings from treated trees.

Overall Awareness and Salience of Pesticide Exposure

The category or concept of “pesticides” was initially interpreted by the women as chemicals used on crops. It did not necessarily include chemicals used to control pests around the house such as insects, rodents, or weeds. Many mothers initially indicated that they had never applied pesticides, then went on to describe using a variety of household and garden pesticides in the United States and in Mexico. Many women were unsure about the details of their partners’ work activities and did not necessarily link the activity of *esprayando* (“spraying”) with the application of pesticides. Others were aware that chemicals were being used but only knew that the purpose was “to dry out the grass” or “to help the plants grow.” Very few could provide either the chemical or brand names of the pesticides they or their partners used at home or in the fields: “To be honest with you, I never think about pesticides when my husband is using them. Sometimes he goes to work and I don’t know what he is doing” (26 years).

In general, smell was the most salient aspect of pesticides and was considered the primary indicator of the presence and strength of chemicals. Participants talked about

the strong-smelling liquids that were applied to the Christmas trees and how the smell can make one feel ill. The smell was considered the most important attribute of pesticides and figured prominently in the participants' thoughts and discussion about pesticides. Absence of odor was evidence of the absence of danger from pesticides. This odor theme forms a thread throughout the model of pesticide exposure and risk:

I asked the [landlord] if [the pesticide he applied to our house] is dangerous for my son, and he says it isn't. And there is no odor. Like, if it has a strong odor or something [it would be dangerous]. But no, you cannot smell anything. (26 years)

When we spread [pesticides] . . . I clean well . . . I try to spray, eh, what is it called? Other fragrances, for example, candles so as not to smell. (23 years)

Participants varied widely in their awareness of pesticides being used around them and the implications of the presence of pesticides in the environment. Although some women were concerned about pesticides in food, several women never fully understood the concepts of pesticides or exposure despite efforts to define them straightforwardly. A few mothers knew of someone who had become ill from drinking or spilling pesticides on their skin but were not aware of the potential for long-term effects. A few told stories of someone far away and long ago dying or suffering birth defects from acute pesticide exposure, but these stories were of people whom they did not know well or at all.

Experience, Information, and Education Related to Pesticides

The women in the study reported limited experience with pesticides, and that experience was more likely to have occurred in Mexico than in the United States. Because most of the families came from rural settings in Mexico, they grew up living and working on family farms. Usually their fathers and brothers were responsible for applying pesticides. A few women felt that pesticide use in general was less common in Mexico or at least that pesticides used there were weaker than those used in the United States, as assessed by the relative strength of the smell. Most described using pesticides in the home or in the garden to eliminate mosquitoes, mice, and flies, whether in the United States or in Mexico. The few women who had themselves applied agricultural pesticides worked in nurseries or tobacco; more often a boss or other male employee would handle the chemicals. More commonly, participants reported having worked in areas that had been treated, but they did not know what had been applied nor if there had been any restrictions on working there:

There were times when the farmers made us work after they had just sprayed in the morning, or one day earlier, but later a pesticide program started, and they put signs up and wouldn't let us go in until 8 days after they sprayed. But before, the farmer didn't care about sending us in. If he had sprayed the day before, he'd make us work. (45 years)

Well, they've never told us "Look, you're going to work here and they've already applied pesticides," no, but we're pretty sure that with tobacco, at any given moment they've sprayed pesticides for pests or something like that. (31 years)

Those women who had used any type of pesticide freely admitted to doing so despite having learned little or nothing about them. Only one (with university-level training in

chemistry) had more than a rudimentary background in pesticide safety and use. Pesticide safety training in Mexico is commonly received from vendors at the point of purchase or from simply reading the label (Arcury, Quandt, Rao, & Russell, 2001). The women were not sure what, if any, safety training their partners had received. A few were fairly certain that their husbands had not received training either in the United States or in Mexico. Others thought that their husbands might have received training from their bosses (as required by the Worker Protection Standard of the United States Environmental Protection Agency), most likely a video shown each year at the beginning of the season (United States Environmental Protection Agency, 1992).

We have never talked about it, but I believe that the only information he received [was] in Mexico when he would buy pesticides. Instructions come with them, as well as the risks and possible effects. I believe it is the only thing he has read because I don't think he has received any other information. (26 years)

I think that they have trained him on pesticides because sometimes he talks to me about things like that, but I don't understand because I don't know about that. (28 years)

The women learned the little they knew about pesticide safety practices from their partners, although communication on the topic was minimal and not always effective. The practice that the women were the most likely to have learned from their partners was the importance of laundering work clothes separately from the rest of the family's clothes. However, the mothers also noted that they had to wash family clothes separately anyway because the work clothes were covered in dirt and smelled of pesticides. Mothers recognized the need to protect children from pesticides but were vague about why or where they had learned that.

Perceptions About the Risks, Significance, and Prevention of Pesticide Exposure

The concept of exposure to pesticides was difficult to grasp for many of the women. Most did not conceptualize residential pesticides as a potential source of exposure. As a result, most were unable to immediately bring to mind ways in which their families could be exposed to pesticides. Once the concept was clarified, the mothers again displayed a broad range of beliefs. One mother presumed that pesticides were present everywhere and that it would be impossible to avoid them. More commonly, they maintained that only those who directly work with pesticides can be exposed to them or that exposure only occurred if one were in or near an area being treated:

If you go by just as they are spreading the poison, right? And you breathe it in. . . . It is only dangerous while they are spreading the poison. After 2, 3, 4 days, the danger is gone because the strength is all gone. (42 years)

Nearly one-third of the mothers thought of pesticides as "contagious" or exposure as an "infection." They spoke of children being infected (*se contagia*) by mixing work and family clothing in the laundry, lack of hand washing, eating unwashed produce, or being hugged by parents immediately after work: "None of us have gotten infected at all. And they were, the four months I was here, they were spraying, using chemicals on the little trees. And we haven't gotten infected because we're careful to keep the clothes

separate" (26 years). "Well, I think that you get sick when you . . . eat vegetables or fruits without washing them right? That's when you get infected" (30 years).

Individuals who worked directly with and around pesticides were generally thought to be at the greatest risk of exposure and of "infecting" others. Men were considered more likely than women to be exposed because their work requires them to be around chemicals. This risk could be managed or eliminated by following the boss's instructions and wearing personal protective equipment. However, several women were fairly certain that their partners did not use any special protective gear in the field, beyond perhaps covering the nose with a handkerchief in order to avoid inhaling (i.e., smelling) the chemicals: "[The family would] be exposed when my husband gets here if he came inside, but he comes in downstairs when he uses that, and he showers. I don't think you can get infected once he's taken a shower" (29 years).

Children and other family members who did not do field work were considered to be at less risk because they do not enter the fields, and they have no reason to handle pesticides. Their primary exposure route is through contact with the clothing of farmworkers living in the house. Children were generally allowed to play outside as long as they were not in danger from nearby traffic. Very few mothers took their children to the fields, probably because most did not themselves work in the fields. The few who did allow their children near the fields felt that as long as the children did not actually touch the crops, that is, played only in furrows or along the edge of the field, they were not in danger of exposure. If the odor of pesticides was in the air, children would be kept indoors until it dissipated. They were generally unfamiliar with the concept of pesticide residues that remain on plants and other surfaces long after the chemical is no longer visible: "If you go to the fields and they are spraying . . . pesticides, then you get exposed. . . . Yes, if you don't go to the field, then you are not [exposed], right?" (32 year). "Just my husband [is exposed to pesticides] because he sprays or uses fertilizer at work, but I never mess around with the Christmas trees, and our son, even less. We're always in the house" (26 years).

Beliefs About the Effects, Symptoms, and Severity of Pesticide Exposure

Beliefs about the effects, symptoms, and severity of pesticide covered the spectrum from no effects to fatal. Some women simply were not sure what the effects or symptoms might be or whether there were any differences by gender or age. Only a few thought that the effects and symptoms would depend on the amount or type of exposure. Some thought that women and children would be more affected by the same exposure because of their smaller size and different physiology. Children were not used to these strong smells and had more delicate skin. Stronger smells were associated with greater toxicity and potential for harm:

I think it causes the same harm, but in a different way [in men and women]. For example, I think that [women] are affected more in the entire body and a man, I think, just in his head. . . . I think that in children, it's in the whole body because they have fewer defenses. I mean, their organs are smaller. . . . [If a pregnant woman] is in an area where it smells bad or where chemicals filter onto your body, then it's logical that the baby is absorbing them, and I think it's logical that its development can be damaged. (45 years)

Even if you wash [work clothes], sometimes the smell doesn't go away. It is not good for the children. (23 years)

The mothers in general did not distinguish between the symptoms and the effects of pesticide exposure. They speculated that pesticides might cause headache, dizziness, drowsiness, fatigue, elevated blood pressure, nausea, and skin rashes, but these were just guesses. Many of these symptoms were actually attributed to the smell, or a combination of heat and smell, more than to the chemical itself. Avoidance of the smell of pesticides reduces the chances of suffering any ill effects. A small number of women had heard that there might be long-term effects, such as sterility and birth defects. But most indicated that they were simply guessing at the effects and symptoms because neither they nor anyone of whom they were aware had ever been affected by pesticides: "I have never learned about [symptoms of] pesticide exposure. I have never learned about pesticides. . . . I honestly cannot think of anything because I have no idea how harmful pesticides can be" (23 years).

A few individuals who were not convinced that pesticides affect people pointed out that pesticides were poisonous to insects, but not people. That is, they only affected the targeted organisms. Even if they were poisonous for people, the concentration was so low as to be unnoticeable, and absorption would not be dangerous: "I think it is special for bugs, for insects, that it doesn't do anything to you. I don't think it's that strong. It's just for insects" (41 years).

Treatment of Pesticide-Related Illness

Two distinct approaches to treatment were suggested depending on whether exposure was conceptualized as poisoning or an infection. In the case of poisoning, some sort of "detoxification" was necessary to cleanse the system of poisons. For example, the victim's stomach might need to be pumped. Many participants suggested drinking large quantities of milk, coffee, or water to dilute the poison, to induce vomiting, and to flush it out of the system. Alternatively, participants also recommended seeing a doctor who might prescribe medicine such as antibiotics or give some sort of unspecified injection. This belief is consistent with the infection/contagion perception of exposure.

These beliefs about exposure and treatment were not mutually exclusive in the interviews, nor were individual women always consistent in their views of exposure and treatment. Holding one view of exposure did not necessarily mean holding only the complementary view of treatment. For many women, the various perspectives coexisted:

The only thing I would do is to go see my doctor. And she would prescribe for me what I have to take. But the thing that comes to our minds when people in Mexico have problems with pesticides is to drink milk. That's the only thing that people do when they are getting poisoned. (33 years)

Behaviors to Manage Pesticide Exposure

Pesticide exposure management consisted mainly of proper handling of the work clothes. Contact with work clothes that smell of pesticides was thought to be the primary source of exposure for family members, especially children. Nearly all women reported handling the laundry as recommended, that is, storing and washing them separately from the family's clothing. Many partners changed their work clothes, or at least boots, outside the house or in the bathroom. Most workers also showered reasonably soon after work, especially on days when they had been spraying. Overall, the mothers felt there was little that could be done to keep pesticides out of the house other than closing the windows during spraying.

If indoor pesticide application was unavoidable, less-strong-smelling chemicals should be used if children are present. The whole family would leave the house until the smell dissipated, and children would be warned not to touch anything that might be contaminated until it was cleaned with hot water and perhaps bleach. Other measures to protect children included spraying chemicals into the air rather than on accessible surfaces and spreading the contents of a rat poison box under the sofa rather than placing the intact box out in the open. Home pest control methods that were not considered pesticides included flypaper, cockroach bait, mousetraps, cleaning the house with chlorine bleach, and spraying with disinfectant sprays. In the case of the latter two methods, the smell of the bleach or spray was believed to repel pests.

Few women reported actively trying to remove pesticides from their home, noting that it was probably an impossible task. Removing pesticides, if at all, was accomplished by opening windows and cleaning thoroughly with household cleaners, bleach, or alcohol to eliminate the smell. Although not specifically presented as a technique for reducing exposure to pesticides, nearly half the mothers reported using chlorine bleach as an all-purpose cleaner. It was added to laundry, used for mopping floors and cleaning other surfaces, and even used for washing eating and cooking utensils. Bleach was thought to clean all kinds of dirt and grease, kill bacteria, and rid the house of pests. It was used on nearly every surface of the house, including children's toys: "I think that's why I don't have roaches, because I use Clorox in the whole house. I mop with Clorox. That's why" (19 years). "When we spread the insecticide, I washed everything very well, especially her things. We put her things in the refrigerator, but still her toys were washed again. And we wash everything with bleach" (23 years).

DISCUSSION

The women who participated in this study described models of pesticide exposure that were similar, but not identical. To the extent that they understood the meaning of *pesticides*, they agreed that pesticides were potentially hazardous to humans. However, the salience of that hazard in their day-to-day lives varied considerably, as did their knowledge and beliefs regarding exposure. A small number had difficulty conceiving of the idea that they or their children could be exposed to pesticides as a result of their partners' occupations as farmworkers. A larger number of women were aware of the possibility but did not identify it as a health problem. They therefore took few protective measures beyond avoiding or eliminating the smell of the pesticides. Even those who were fully aware of the possibility and danger of exposure, especially for children, felt they had limited control over it. No individual participant had a broad or overall understanding of the many aspects of the pesticide exposure process.

Two thematic threads run throughout the interviews. First, *work-related* contact with chemicals was considered the main, if not only, means of exposure. Even those who characterized pesticide exposure as an infection or contagion that could be passed to others described the pathway as being contact with a worker's contaminated clothing or skin. Field workers were therefore thought to be at the greatest risk for exposure, whereas children and women who do not do field work were at minimal risk. Children were believed to be protected as long as they were not permitted into fields, protected from contact with dirty work clothes, and prevented from touching contaminated objects. Although the women were vague about the implications of pesticide contact for

adults, they were consistent in their belief that children should not be allowed to come in contact with pesticides. Whatever the effects of pesticide exposure might be, they would be more severe for children because of smaller body size and weaker, more delicate systems. But as they believed—mistakenly—that children had little or no contact with pesticides, they considered the likelihood of harmful effects to be minimal.

Second, the *odor* emitted by chemicals was considered the primary indicator of their presence in the environment and their degree of toxicity to humans, especially children. Strong-smelling chemicals were considered more dangerous than those with faint odors, and the danger declined as the smell dissipated. The smell was thought to be responsible for many of the presumed symptoms of pesticide poisoning or exposure, such as dizziness, vomiting, and headache. A chemical odor was considered evidence of both potential and actual contact. Therefore, elimination of the odor from clothing or the house meant the pesticides were no longer present. The effect of pesticides on an individual depended on his or her ability to tolerate the smell, a factor that might vary by age, gender, and body size. If pesticide use was absolutely necessary, less-strong-smelling chemicals posed less risk, especially to children.

Chlorine bleach plays a special role in the women's perceptions of managing exposure. Although not thought of as a pesticide by the women, it is categorized as one by the United States Environmental Protection Agency. According to the women's model, chemicals or substances with stronger smells have greater potency, both positive and negative. Strong-smelling (i.e., highly toxic) pesticides could be removed with another strong-smelling (i.e., powerful) cleaner such as bleach. Chlorine bleach was a popular means for eliminating both pests and pesticides from the home. Despite its strong smell, it was not thought to be harmful to humans nor classified as a pesticide by the women.

Most studies on farmworker beliefs or perceptions of pesticide exposure and health risk were conducted with men, and most were focused on occupational exposure. Even so, noteworthy similarities exist between the findings of these studies and the present study. The general sense of lack of control over exposure is a common finding (Austin et al., 2002; Elmore & Arcury, 2001; Grieshop, Stiles, & Villanueva, 1996; McCauley et al., 2002; Sticker, Bryan, Lasarev, & Scherer, Quandt et al., 1998; Vaughan, 1993). Lack of sense of control was associated with lack of safety training and reduced likelihood of taking preventive measures (Austin et al., 2002; Elmore & Arcury, 2001; Vaughan, 1993). The use of milk to treat any type of poisoning, including pesticide, was reported in studies with similar populations from Mexico (Arcury & Quandt, 2001; Rao, Quandt, & Arcury, 2002).

Several studies noted the lack of experience with illness from acute pesticide exposures reported by participants. This might have been because no one they knew had ever experienced a pesticide-related illness. On the other hand, it is possible that participants did not make a connection between exposure and subsequent illness (Elmore & Arcury, 2001; Harthorn, 2003; Quandt et al., 1998; Vaughan, 1993). The significance of some form of sensory indicator (e.g., smell, taste) as necessary evidence of exposure has been noted in other studies (Harthorn, 2003; Quandt et al., 1998), as has the use of milk or other liquids as a treatment for poisoning (Rao et al., 2002). The belief that susceptibility to negative health effects from exposure varies by age, gender, and individual "strength" has appeared in other studies (Elmore & Arcury, 2001; Harthorn, 2003; Quandt et al., 1998). Additional findings from this study that have not been reported elsewhere include the characterization of pesticide exposure as an infection or contagious event and the notion that smell is an indicator of effectiveness of cleaning liquids.

Despite their limited samples and methods, the two California studies that focused on women's perceptions of pesticide exposure produced very similar findings. In Harthorn's (2003) study, participants initially did not consider themselves to be exposed but later described situations in which they were clearly at risk. The same situation occurred during the interviews in this study. Those participants also relied on smell, taste, or inhalation as evidence of exposure. The women in Goldman et al.'s (2004) study followed safety recommendations only on occasion despite having some knowledge of the hazards of pesticide exposure.

The findings of this study have important implications for applying the precautionary principle to this specific environmental hazard for this population. *Awareness* of the hazard was limited by the women's lack of experience and training, by not being familiar with their husbands' work activities, and by the fact that they had no personal experience or knowledge of anyone suffering ill effects from exposure. They were not aware of exposure pathways other than individual physical contact with the substance and relied on odor to determine the presence or absence of pesticides in the environment. They did not realize that pesticides and residues often have no detectable odor.

The women's perceptions of *risk* were also guided in large part by the presence or absence of an odor. Less-strong-smelling chemicals were less dangerous, especially for children. Strong-smelling chemicals became less dangerous as the smell dissipated. As long as an individual did not personally have direct physical contact with pesticides, the likelihood of him or her suffering ill health effects was thought to be small. Field workers were more likely to suffer ill effects than non field workers or children because their exposure is more direct and concentrated.

Lack of specific knowledge about pesticides and their effects limited the *control* the women felt they had over managing the risk. The most common means of controlling exposure was to wash work and family clothing separately. Other control measures concerned the environment within the house, such as closing the windows during nearby field applications or cleaning indoor surfaces with bleach. Again, most of the control measures were intended to eliminate the smell of pesticides—if present. Even when they knew of measures to control exposure, such as bathing and changing clothes immediately after work, demands from children and others in the household made taking them difficult.

IMPLICATIONS FOR PRACTICE

The model of pesticide exposure described by the women in farmworker families in this study contains beliefs that both agree and conflict with current scientific understanding and US-EPA (1992) recommendations. Effective pesticide safety education programs will encourage preexisting protective beliefs and behaviors (e.g., separating laundry, avoiding inhalation), while discouraging or modifying beliefs and behaviors that increase risk (e.g., odor as an indicator of presence or toxicity). Some practices fall outside the scope of scientific understanding and recommendations regarding management of pesticide exposure but still have educational implications, such as the practice of drinking large amounts of liquid to treat poisoning.

These findings have several important implications for occupational health policy and health education. Current policy (US EPA Worker Protection Standard) limits required pesticide safety training to field workers and pesticide handlers (US EPA, 1992). This policy should be expanded to include providing information to those who live with farmworkers, for example, provide brochures or videos for workers to take home after

workplace training. Health education efforts also should be developed that provide information to the family members of farmworkers about pesticides as well as other environmental health hazards. Health educators and outreach workers from migrant clinics, rural county health departments, and cooperative extension offices need to present pesticide information for women who live with farmworkers with other environmental health information (e.g., lead safety, food safety). Educational content needs to address the models identified here in order to be culturally appropriate. This content must increase awareness of exposure in the home to residential as well as agricultural pesticides. It should address that odor is not the only indicator of pesticide exposure in the home and provide specific sources of residential exposure. Finally, it must provide information on how to control pesticides in the home, including appropriate cleaning techniques and the use of alternatives for controlling household pests. We have used these results to inform ongoing lay health adviser/*promotora de salud* programs in pesticide safety, in which we emphasized the importance of managing residential as well as agricultural pesticide exposure and the fact that pesticides can be present even when there is no odor (Arcury et al., 2000; Lane & Arcury, 2003; Lane, Arcury, Quandt, & Marín, 2003). The materials that we have developed for providing this pesticide safety information, including teaching plans, brochures, comic books and videos, are available upon request.

CONCLUSION

The generalizability of this study is restricted by its small sample size and limited geographic scope. This component of the larger project was ethnographic in nature, so the sample size was necessarily small. The geographic extent of the study was limited to the mountains of North Carolina and Virginia, which have an agricultural context distinct from other areas of the country in terms of crops and labor. Nevertheless, the findings overlap strikingly with those of studies conducted in different parts of the country and with different Latino farmworker communities. The systematic qualitative research design employed in this study provides reliable and valid results with limited samples (Patton, 1990).

Pesticides pose a significant environmental health risk that is not easily assessed or likely to be eliminated in the near future. A few women in the study asked us whether the amount of exposure their family experienced was dangerous. At this time, this question can only be addressed in terms of *the precautionary principle, which states that until science is able to determine the danger level with certainty, exposure should be minimized* (Weiss et al., 2004). While science continues to grapple with the question of “how much is too much,” measures need to be taken to minimize exposure. Basic pesticide safety education for women in farmworker households needs to start by increasing their awareness of risk in a way that convinces them of the importance of avoiding exposure and provides them with the means and motivation to take action to protect themselves and their families.

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