Reporting Pesticide Assessment Results to Farmworker Families: Development, Implementation, and Evaluation of a Risk Communication Strategy

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The collection of environmental samples presents a responsibility to return information to the affected participants. Explaining complex and often ambiguous scientific information to a lay audience is a challenge. As shown by environmental justice research, this audience frequently has limited formal education, increasing the challenge for researchers to explain the data collected, the risk indicated by the findings, and action the affected community should take. In this study we describe the development and implementation of a risk communication strategy for environmental pesticide samples collected in the homes of Latino/a migrant and seasonal farmworkers in a community-based participatory research project. The communication strategy was developed with community input and was based on face-to-face meetings with members of participating households. Using visual displays of data effectively conveyed information about individual household contamination and placed it in the context of community findings. The lack of national reference data and definitive standards for action necessitated a simplified risk message. We review the strengths and weaknesses of such an approach and suggest areas for future research in risk communication to communities affected by environmental health risks. *Key words:* agriculture, children, community, environmental justice, exposure, health communication, house dust, Latino/a.
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An increasing number of environmental health studies are collecting samples to assess exposure to pesticides. Household studies use environmental samples such as surface wipes, soil samples, air monitoring, and vacuum dust collection (Simcox et al. 1995). Biomonitoring studies sample fluids including urine, blood, and meconium (Hong et al. 2002; Whyatt and Barr 2001). The success of these studies in detecting pesticides and their metabolites reflects the rapid advances in analytic technology.

Public awareness of environmental exposures and their possible health effects has heightened. Individuals and communities from whom samples are taken expect to be informed of study results and the implications of those results for their health. The increase in community-based participatory health research (Arcury et al. 2001; Israel et al. 1998; Thompson et al. 2003), with its ethic of open sharing of information, is producing an increasing number of instances where laboratory results of toxic exposures need to be reported by scientists to the affected community. In addition, institutional review boards now frequently require that results be reported to study participants, and they are reviewing risk communication materials before findings are released.

The general problem inherent in presenting research findings and risk messages to individuals and communities is adapting the message to the needs, concerns, beliefs, and knowledge base of these individuals and choosing effective channels for delivering the message (Hatfield 1994). Low levels of health and science literacy of the general population (Gazmararian et al. 1999; Lipkus et al. 2001) present a major obstacle to scientists who typically are not trained in communication. For example, numeracy—the ability to use numerical concepts and to perform basic probability operations—is especially important for individuals to judge data on their risk of harm from environmental exposures. Low numeracy is common throughout the population, but it especially prevalent among persons with low educational attainment (Gazmararian et al. 1999). These segments of the population are often the focus of environmental justice and environmental exposure research.

Within environmental health, considerable attention has been directed to risk communication (Covello and Allen 1992; Goldstein and Gotsch 1994). However, existing models for risk communication focus on communicating general risk messages to communities, not on communicating specific exposure or risk data to individuals. Models for communicating lead risks are an exception; lead has a fairly well-established risk profile, and substantial effort has been devoted to screening and reporting results to parents (Advisory Committee on Childhood Lead Poisoning Prevention 2000). Information on other environmental contaminants such as pesticides, however, may be more difficult to communicate to individuals. Exposures to pesticides are heterogeneous, and the effects are delayed, varied, or undocumented, so no simple risk message has been established.

The public's desire for information, the state of the science evaluating the actual health dangers of exposures, and the analytic technology to detect pesticides are frequently at odds. Although the technology to detect even low levels of toxic exposure continues to improve, research to demonstrate the health effects of such exposure is still incomplete. Study participants, therefore, have few appropriate data to which they can compare study results. Thus, the health risk message to be reported is not always clear. This presents several challenges as scientists attempt to communicate honestly and accurately but in a format that can be understood by the lay public. Because the lay public often perceives risk in a social context that can magnify some risks relative to others, more qualified answers of scientists may be perceived as evasive or intentionally deceptive (Miller and Solomon 2003).

This article reports how pesticide risk assessment data were communicated to individual farmworker families participating in a child health intervention in North Carolina and Virginia. Farmworkers constitute a population at considerable risk of exposure to pesticides; in the United States, they frequently are Latino/a immigrants who have low levels of formal education and do not speak or read English (Villarejo 2003). We first describe the context of the study. We then describe the process through which the risk communication strategy

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was developed and implemented. Finally, we qualitatively evaluate the strategy and discuss its implications for risk communication in other studies.

The La Familia Study

The La Familia Study is a community-based participatory research project designed to develop, implement, and evaluate a lay health advisor intervention to reduce pesticide exposure among families of migrant and seasonal farmworkers. The study involves a partnership of environmental scientists at Wake Forest University School of Medicine with community members and advocates involved through the North Carolina Farmworkers Project (Benson, NC), a community-based nonprofit agency. Formative data to assist in the development of the intervention were collected between June and December 2001 from 41 households located in four western North Carolina counties and two southern Virginia counties. Each household consisted of a family of at least two related persons, one of whom was a seasonal, migrant, or year-round farmworker. A farmworker was defined as a person whose primary source of income comes from performing activities in the production of agricultural crops (including Christmas trees and ornamental plants) or processing of those crops (including making wreaths and packing produce) while employed by someone outside of his or her family. At least one adult in the family had to have a child between 12 and 84 months of age residing in the house.

The lack of a census and the dispersed nature of farmworker residences in the mountains precluded the use of a random sample or a block cluster design. Therefore, a strategy was developed to obtain a sample representative of the variability in the local farmworker population (Arcury and Quandt 1999) by recruiting at sites (e.g., English-as-second-language classes, women's groups, migrant health programs) where families were likely to be enrolled.

The 2001 formative data collection took place in the participants' home when at least one child in the target age range was present and consisted of an interviewer-administered questionnaire of fixed-response and open-ended questions, collection of wipe samples, and observations of the residence and neighborhood. Interviewers were bilingual females; they communicated in the participant's preferred language, which, in all cases, was Spanish. The formative interview questionnaire was administered to the mother of the child; it gathered information including her knowledge, attitudes, and practices concerning residential and agricultural pesticides. After describing the study and answering questions, informed consent was obtained in accordance with procedures approved by the Wake Forest University School of Medicine Institutional Review Board. During the informed consent procedure, the adult consenting was told that results of the pesticide assessment conducted in her residence would be reported after laboratory analysis. No further details of this reporting procedure were given at that time.

Wipe samples from three types of surfaces (floor, toys, and children's hands) to be tested for pesticides were collected in each home using procedures described elsewhere (Quandt et al. 2004). Samples were analyzed for eight pesticides most commonly used in agricultural settings (atrazine, disulfoton, esfenvalerate, lindane, metolachlor, oxyfluorfen, pendimethalin, simazine) and 13 pesticides commonly found in residential settings [carbaryl, α-chlordane, γ-chlordane, chlorpyrifos, 4,4′-dichlorodiphenyldichloroethylene (DDE), 4,4′-dichlorodiphenyltrichloroethane (DDT), diazinon, heptachlor, methoxychlor, *cis*-permethrin, *trans*-permethrin, *ortho*-phenylphenol, propoxur]. Analysis procedures have been described elsewhere (Geno et al. 1995, 1996; Quandt et al. 2004).

Development of the Communication Strategy

Three steps were followed in the development of the communication strategy: *a*) Environmental health scientists listed the challenges they anticipated in delivering results and risk information; *b*) other scientists and community-based participatory research projects were queried for existing examples of communication materials and plans; and *c*) community members were interviewed to learn what they wanted to know about the results of the pesticide sampling.

Anticipated challenges. One of the primary concerns of the environmental health scientists was that an exposure measurement provides a measure of only a particular chemical in a particular medium (in this case, surface wipes) at a particular time. Therefore, it cannot capture either temporal or spatial variability in pesticide distribution. The collection of wipes had taken place from June through December 2001. Some of the most significant pesticide applications for the major crop (Christmas trees) take place earlier in the growing season (i.e., spring). Residential pesticides can be applied at any time. There was no way to know whether pesticide concentrations on the day wipe samples were taken represented those throughout the season. Nor was it possible to know whether the pesticides detected were still present when risks were communicated to the farmworker family. Although a systematic strategy had been used for choosing floor areas and toys to wipe, the concentrations detected might not have been representative of all floors and toys with which the child came in contact. Some residences had little bare floor area, and carpeted areas were not sampled because of the decision to use wipe rather than vacuum sampling.

Another anticipated challenge was trying to explain whether or not a particular level of pesticide detected constitutes a health risk. Unlike residential lead, for which clear health effects have been established at all levels of exposure and action levels set [Centers for Disease Control and Prevention (CDC) 1997], the health effects of pesticides, particularly at low levels, have not been determined for children, nor have action levels been established on which to base advice to parents. At the time the information was delivered to the families, no normative data for environmental pesticide samples were available.

A final anticipated challenge was presenting the information in a format that would be easily understood by the participants. The data displays needed to be multivariate and reveal several layers of information in a user-friendly format.

Existing examples of risk communication strategies. The investigators conducted a search to find examples of risk communication plans used by other environmental health scientists. The most directly relevant came from researchers at Oregon Health and Science University, who displayed data for individual households on six metabolites for several dust sample types (e.g., floors, cars) using a multicolor grid (McCauley L., personal communication). The investigators attended a discussion of risk communication at the annual meeting for investigators at the National Institute of Environmental Health Sciences Children's Centers (22 January 2002, Research Triangle Park, NC). Few of those investigators had yet communicated specific information to individual research participants. Instead, summary findings were most often compiled and presented in newsletters and public meetings. Examples of communications directly to study participants were obtained from the National Center for Environmental Health (NCEH) of the CDC. Letters, in English and Spanish, were obtained that informed families of results of biologic sampling for heavy metals. As part of the letter about the study, the results for the family were displayed on a visual analog scale, with a smiling or frowning face symbol, depending on the level of metals detected. Parents were instructed to take no action, to take the child back to the clinic for routine testing, or to take the child for immediate testing and treatment, depending on level of chemical detected. Two useful examples of summary findings to the community were also obtained from the NCEH (Rubin et al. 1997). The first was a brochure of frequently asked questions and answers, written in lay language. The second was a figure, using photographs and minimal text to convey the pathway of chemicals into the environment, through the food chain and into humans.

In evaluating these examples, the investigators noted that written communications to farmworkers needed to take account of language and literacy status. The farmworkers' family members (generally, wives) to whom risk communication would be addressed preferred oral communication in Spanish. Many had limited formal education. Interviewers observed during the 2001 formative interviews that some preferred to have written materials read to them. The literacy status of husbands and other family members who might view any written materials was not known. Therefore, it was decided that communication would be oral, with any written materials being very simple and using pictures or diagrams, where possible.

Seeking community input. From analyzing data collected in the formative interviews at the time of wipe sample collection, the health scientists knew that most of the women had limited knowledge of pesticides. For example, when asked, few knew what a pesticide was, the names of any pesticides, or the health consequences of pesticide exposure. However, additional information was needed to get a better idea of what farmworker families wanted to learn in the risk communication process. Informal interviews were conducted with some of the women who had participated in the formative research and were waiting to learn the study results. They included one key informant chosen because her background allowed her to bridge both the farmworker and scientific communities. Although her husband worked in agriculture, she had a university degree in chemistry and had worked in the chemical manufacturing industry in Mexico. Previous interviews had indicated that she had an unusually good understanding of the issues of pesticides and health of her family, as well as of the limitations and concerns of other women in the community.

An interview guide was constructed to ask community members what they thought study participants would want to know, whether they would be more interested in their own or the composite data, and how the study team could deal with the ambiguity of knowing pesticides were detected but not whether the level detected was dangerous. As part of the interview guide, they were shown mockups of data displays and asked questions about interpreting them.

The interviews revealed that the community members thought their peers would find it important to compare their homes with the others in the study. In terms of the ambiguity, they thought it was important that the scientists present *la verdad* (the truth). If this meant telling women that it was not possible to know the level of danger represented by the findings, they would prefer to know that rather than to have the scientists give a simpler but incomplete answer. They thought that it would be most important to tell them what they could do to clean pesticides from their houses or reduce the chances of further pesticide contamination. Finally, the community members were able to understand and answer questions about the figures presented.

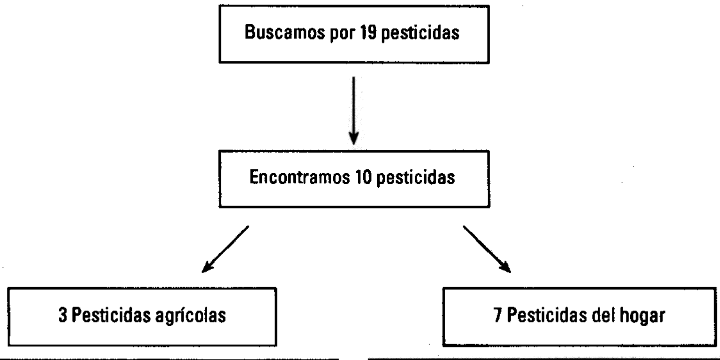
Description of the final plan. Based on consideration of these three sources of information, the final plan was drafted and was approved by the Institutional Review Board of Wake Forest University School of Medicine. It called for the use of a face-to-face meeting of a Spanish-speaking member of the project staff with each woman who had been interviewed and had provided environmental samples. The overall goal of the meeting was to inform the woman of the pesticide risk detected in her home. The specific objectives were for the woman to *a*) know how many and what chemicals had been detected in her home, compared with the number of possible detections; *b*) be able to compare the number of detections in her house with those of others in the study; *c*) know that less exposure of family members to pesticides was preferable to more exposure; *d*) be able to demonstrate understanding of the pathways by which her child could come in contact with agricultural and residential pesticides; and *e*) be able to list some steps she could follow for cleaning pesticides from her home or preventing further contamination.

The investigators decided not to differentiate pesticides found on floors, toys, and hands. In general, those on the hands and toys were predicted by what was on the floor (Quandt et al. 2004), so there appeared to be little loss of information by not differentiating pesticide sources.

To guide the staff member conducting the risk communication, a script was drafted that included the material to be presented, suggested explanations, and questions to elicit indicators of comprehension. The script was organized around a set of questions: What is the purpose of today's meeting? What exactly are pesticides? What was found in your house? How does this compare with other farmworker houses? What do the figures mean? Should you be worried? How do pesticides get into your house? What can you do to get pesticides out of your house? How can you learn more?

Three figures were prepared that corresponded to three of the goals of the meeting. Figure 1 shows a flow diagram to explain how many pesticides the investigators had tried to detect in a home and how many they had found. Although laboratory analysis had been directed toward 21 pesticides, the number of pesticides reported to the participant was 19. *ortho*-Phenylphenol could not be detected because of contamination, and 4,4′-DDE and 4,4′-DDT were combined for presentation. Pesticides detected in the home were divided into agricultural and residential pesticides. Both the chemical and common trade names were given. This figure was explained, and a copy given to the woman.

Figure 2 shows a grid in which 41 rows represent the households and 17 columns represent the pesticides. (One agricultural and



Compuesto químico	Nombre popular
Disulfoton	Di-Syston
Esfenvalerate	Asana
Pendimethalin	Prowl, Stomp

Compuesto químico	Nombre popular
Carbaryl	Sevin
α-Chlordane	Chlordane
γ-Chlordane	Chlordane
Chlorpyrifos	Dursban, Lorsban
Diazinon	Spectracide, Diazinon
cis-Permethrin	Ambush, Pounce
trans-Permethrin	Ambush, Pounce

Figure 1. Example of flow chart used to inform study participants of the number of pesticides found in their residences. Main items translate as "We looked for 19 pesticides," "We found 10 pesticides," "3 agricultural pesticides," and "7 residential pesticides."

one residential pesticide were eliminated because they were not detected in any household.) The cells were shaded to indicate which pesticide was found in which home, with a different color used for each column. No personal identifiers were used. Each household was assigned a number, and the participant knew only which household was her own. A key was available to identify which pesticide (chemical and common trade names) was represented by which column. The staff member described the content of the figure. To introduce a participant to the layering of information, the staff member started by orienting her to the meaning of rows and columns and then finding her row. The staff member then pointed out that some houses (rows) had more pesticides than others, and that some pesticides (columns) were much more commonly found than others. Figure 2 was printed on card stock and laminated for easy handling. It was not left with the participant.

Figure 3 is labeled "How children are exposed to pesticides." Two pathways of pictures lead to a photograph of a toddler chewing on a toy (Figure 3). One pathway shows a sequence of pictures of a male farmworker with a backpack sprayer applying chemicals in a field, and then entering his home in work clothes and boots. The second pathway shows a cockroach on a kitchen floor, and then a person spraying a residential pesticide in the kitchen. Both pathways lead to the toy on the floor, which the child puts into her mouth. A color copy of this figure was left with the participant.

After presenting the information in the three figures, the staff member discussed what the information meant for health. She explained that all but two houses tested had some pesticide in them, and that the residential pesticides found were commonly found in houses in different parts of the United States. She further explained that the specific effects of pesticides on health are not always clear, but that scientists believe that exposure to more types of pesticides and to higher amounts of pesticides is more risky that not being exposed. The women were advised that it is better to be more cautious than less cautious when dealing with the health of family members and that children were more vulnerable to the effects of pesticides than were adults.

The final information presented focused on actions families could take. The staff member reviewed ways to keep homes as free of pesticides as possible. This included steps the family could take to keep dust and pesticides out of the house (e.g., closing windows during crop spraying) and to keep farmworkers from introducing more pesticide contamination from nearby fields and from soiled work clothes (e.g., changing before entering the home). The focus was on practical and realistic steps women could take, given the nature of their housing. It also reviewed a few steps to keep pests out of the house to minimize the use of residential pesticides. The staff member distributed two Spanish-language brochures. One described procedures for storing and washing soiled work clothes separately from nonwork clothes. The other was a comic developed by the project to convey the idea of pesticide residues (Quandt et al. 2001). The staff member also answered any questions the woman had. The women were subsequently invited to enroll in a pesticide

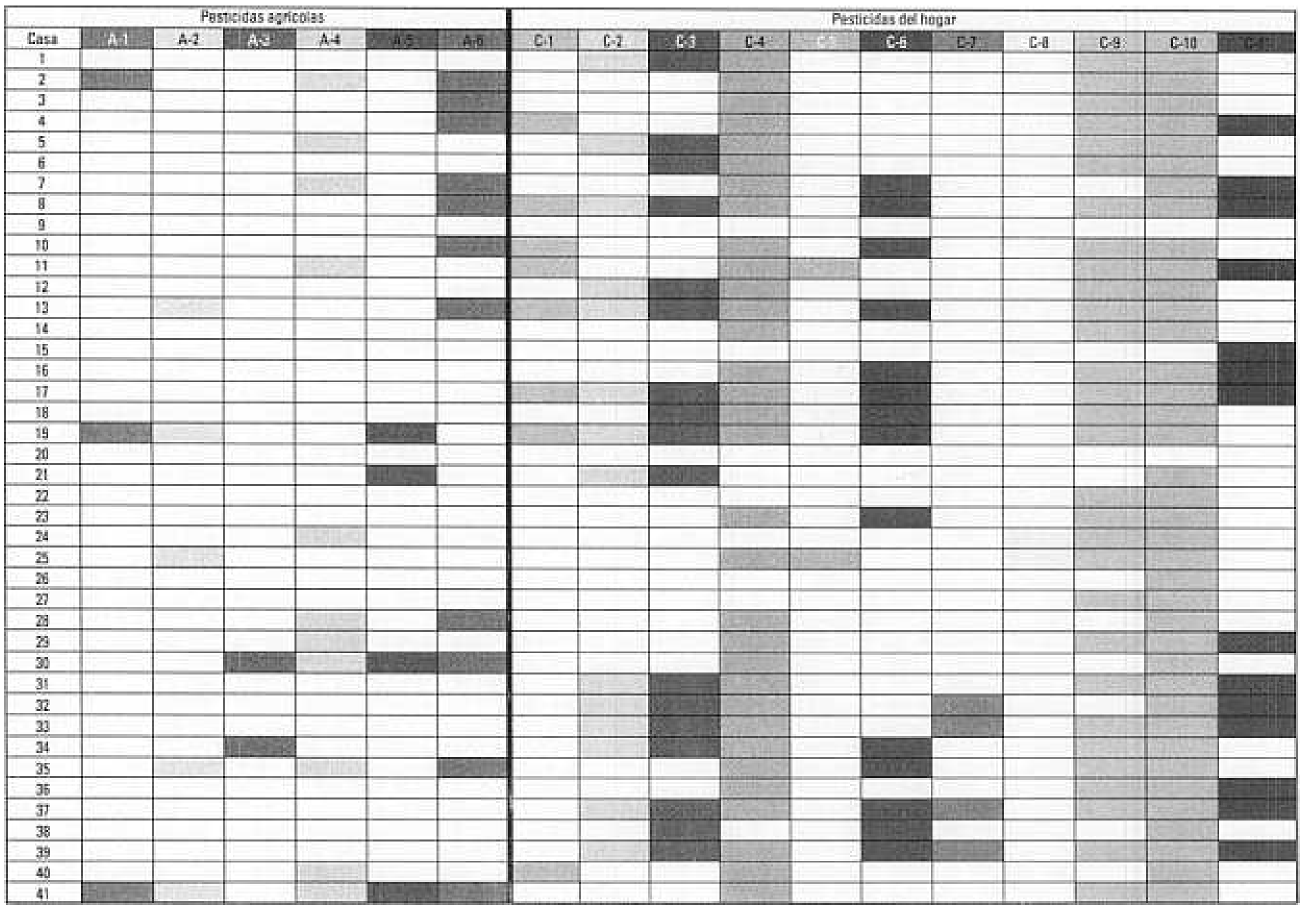


Figure 2. Figure used to allow study participants to compare the number and types of pesticides found in their residences with those of others in the study. A key was shown on the reverse side of the figure to tell what agricultural pesticides were represented by A-1 to A-6, and what residential pesticides were represented by C-1 to C-11. The headings translate as "Agricultural pesticides," "Residential pesticides," and "House number."

safety intervention delivered by lay health advisors. A few of the participants had sufficient interest and leadership skills to become lay health advisors themselves.

The staff member wrote notes after the meeting with each participant and distributed them to all members of the investigative team. These included a description of the circumstances of the meeting, including the setting, who was present, the attitudes of those present, and any distractions. In addition, structured notes were written to address six points: How did the participant react to the news that we found pesticides in the house? Overall, how well did she understand the information that we were trying to communicate? Did she understand the information we tried to convey with the figures? Was she upset by the information? How interested was she in the information? What questions did she have? These notes were compiled and qualitatively analyzed by the other investigators for evaluation, with text segments sorted by the six points. Notes pertaining to each point were read and summarized. For example, information pertaining to comprehension of the figures was sorted according to apparent degree of comprehension, allowing a semiquantitative assessment of that point. Findings from the review of text were compared for two members of the team. Inter-rater agreement for the semiquantitative assessment was 94%.

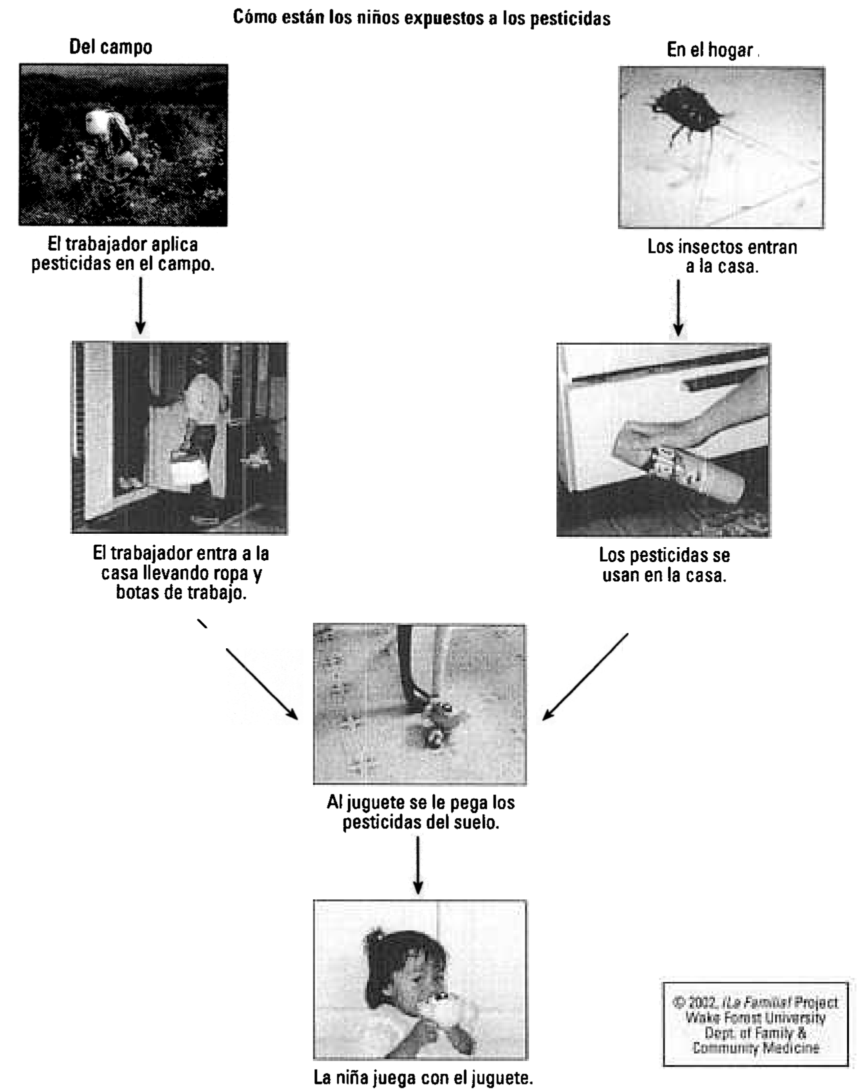


Figure 3. Figure given to study participants to show common pathways by which their children could come in contact with pesticides in the home. Translation of title is "How Children Are Exposed to Pesticides." The agricultural pathway translates: "In the field: the worker applies pesticides in the field. . . .The worker enters the home wearing work clothes and work boots. . . . The pesticides on the floor stick to the toy. . . . The child plays with the toy." The first two captions in the household pathway translate: "In the household: insects enter the house. . . . Pesticides are used in the house." Reprinted with permission of Wake Forest University Health Sciences.

Implementation of the Communication Strategy

Locating respondents. The face-to-face debriefings took place over a 3-month period in 2002, which began 11 months from the first data collection interview and 5 months from the last. The first task before scheduling a debriefing was for project staff members to locate the study participants. Thirty-one of the original 41 were found in the same residence. Of the 10 who had moved, two could be found and were debriefed, for a completion fraction of 33 of 41. Although the whereabouts of six of the remaining eight were reported by friends or social service personnel, none of the six could be located. In some cases, the woman had reportedly moved too far away (e.g., returned to Florida or Mexico). In other cases, even when she was reported to have remained in the area, no phone number or address could be found. The remaining two women could not be located and no information on their whereabouts could be obtained from other sources.

Conducting the debriefings. All women who could be located agreed to schedule a meeting with the staff members. Most were eager to hear the results of the pesticide assessments. The schedules of the women and the staff time required extended the debriefings to 3 months. There was considerable variability in the conduct of the debriefings. They ranged from 30 to 90 min.

Assessment of the Communication Strategy

Overall comprehension. The women displayed good comprehension of the main points of the risk communication interview. Those with direct experience in agriculture seemed to have no trouble. Some of those who had not done farmwork seemed to lack solid background knowledge of what pesticides are and how they might be transferred into the dwelling. Several women required extra explanation. However, by the end of the debriefing, all understood the major points of the risk communication.

Comprehension of Figures 1 and 2. The women had no apparent trouble understanding the information in Figure 1. Most had never heard of the pesticides listed, but they all could understand how many of the two categories of pesticides were found in their homes.

Most (24 of 33) of the women were judged to have understood Figure 2 with no problems. Comprehension was demonstrated by the questions they asked about other households shown on the figure. For example, some women noted the households in which no pesticides were found. Others seemed to try to understand the number of pesticides detected in their own home by finding households with the same or greater number of pesticides. For respondents who did not spontaneously ask questions, the interviewer asked questions to judge comprehension (e.g., Which side of the figure represented agricultural or residential pesticides? Which row represented her household, and how many pesticides were found? Which household had more pesticides than hers?).

Some of the women (6 of 33) seemed to take longer to comprehend the figure. They required additional explanation or use of examples but eventually understood the figure. Although some asked many questions trying to clarify the concepts, others were more passive and required greater probing by the interviewer.

The interviewer was not confident that three of the women (3 of 33) ever fully understood the messages the figure was designed to convey. One seemed to understand the spoken message but made no effort to look at the figure. Another said she did not understand it because there was too much to look at.

Overall, Figure 2 was considered easy to understand once the participant had been oriented to it. By presenting data on all households at once, participants were able to place their own household in context of the community. This provided a means to further interpret the absolute number of pesticides provided by Figure 1.

Comprehension of Figure 3. All 33 respondents were judged to have understood this figure. Many made spontaneous comments that demonstrated comprehension. One woman said,

> From this I have learned that pesticides are the kind of thing that you can't see. Sometimes they are still there on the floor and you don't even know it. This worries me because my daughter likes to sit on the floor and do her homework.

Those with toddlers seemed to identify with the picture of the toddler chewing on the toy.

In cases where the respondent did not volunteer information that demonstrated comprehension, the interviewer asked her to explain it or to role play explaining it to her husband. In all cases, the respondent was able to demonstrate comprehension. The women found the figure appealing. The individuals pictured were from the community, and this piqued the interest of the respondents, who often recognized the individuals in the photos.

Reactions of women to the information presented. There was considerable variability in the reaction of women to the data on pesticide detections in their homes. Many expressed relief, saying that they had been extremely nervous that the debriefing would bring them bad news. Those who had very few pesticides found in their homes were generally pleased. However, among the others, there was no clear relationship between the number of pesticides found and the health concern expressed. Some who had relatively few pesticides expressed grave concern for their families' health. Others with the highest number of detections expressed less emotion, saying that they were not surprised, because of the condition of the house in which they lived.

The women's questions during the debriefing session covered a wide range of topics. Some were basic questions about pesticide safety (e.g., Are the pesticides found in my home dangerous for children?). Others related to the pattern of pesticide detection (e.g., What do the people do who had no pesticides detected in their homes? Do the growers have the same pesticides in their homes that workers do?). And others were practical questions for eliminating pesticides from the home or preventing future contamination (e.g., How can carpets be cleaned without a vacuum cleaner? Is Clorox safe to use as a cleaner? How can I convince my brother-in-law to take off his boots?).

The reaction of the women to the presentation of their results suggested that the communication plan developed was effective in conveying the findings and meeting the plan's objectives. They could discuss the variability in pesticide detections in the homes tested, they knew it was healthier for their families to minimize exposure to pesticides in the home than to do nothing, and they knew some actions they could take to reduce or eliminate pesticide contamination. Although the information in the script answered some, but not all, of their questions, the risk communication meeting seemed to present a teachable moment for pesticide safety.

Discussion

The communication strategy used here was limited by several factors: the nature of the scientific data on health consequences of pesticide exposure, the language and range of educational levels of the farmworkers, and the nature of the farmworker community. Pesticides represent a domain of environmental exposure for which definitive risk communication is not possible. Although reference values are now available for pesticide exposure of the U.S. population to organophosphates, carbamates, organochlorines, and herbicides (CDC 2003), these data are from urine or blood samples and cannot be transformed into equivalent units of pesticide mass detected through dust, soil, or surface wipes. More important, there are no studies of a sufficient number of pesticides and their health consequences at various exposure levels to provide definitive statements of risk. The effect of multiple simultaneous pesticide exposures is similarly unknown. Therefore, the choice was made to keep the statement of risk relative (less exposure is better) and nonspecific (not differentiating types of pesticides by their toxicity).

Language and educational range limited the types of materials that could be distributed and how they could be communicated. Using figures based on presence or absence of pesticide residue meant that some information was lost, most notably quantification of pesticide mass. Although total pesticide mass could have been presented graphically, the choice was made to focus on the large number of types of pesticides present in the study homes. This conveys a message that families are at risk from multiple sources but does not tell how great that risk is. Also, the sites of detection were not differentiated, even though pesticides on the child's hand are clearly closer to being absorbed into the body than are those on the floor. These decisions meant that research participants were given less information than the researchers actually had at their disposal.

The fluid nature of the community limited communication. Eighty percent of the families were located for risk communication. This is higher than the retention rates found in previous attempts to recontact male farmworkers in North Carolina, which were approximately 65% (Quandt et al. 2002). Group discussion of risk may have generated more questions and explanations to meet community member needs than did the one-on-one presentation used. Because families live in dispersed settlements, not in camps or barracks, presenting results at community meetings was not practical. Many women do not drive or have access to transportation to attend such a meeting. Had such a meeting been scheduled, it is likely that most of the women would have attended with their husbands. This would have created a substantially different dynamic in the meeting. It is quite likely that women would have asked fewer questions in such a group setting, and they would have been hesitant to raise concerns that involve trying to alter the behavior of their husbands and other male household residents to reduce the amount of pesticides introduced into the household. In contrast, the one-on-one discussion in the home provided opportunities to discuss specific risk factors for a family.

Study participants' comprehension of the risk communication materials was judged through their comments, questions, and responses to discussion initiated by the staff member conducting the debriefing. However, qualitative assessment of response using multiple raters according to established analysis conventions (Miles and Huberman 1994) contributes to the robustness of the findings.

No specific tests of comprehension were conducted. Because there is no absolute standard for judging the risk of pesticides, one might suppose that respondents could take one of two approaches to understanding the data. One was an absolute appraisal, which said that the best scenario was to have no pesticides and anything above that represented a problem. The other was a relative appraisal, comparing oneself with others. Because there were several houses with a high number of pesticides, most respondents could assure themselves that things in their own house were better than some others in the community. Because the latter approach encourages complacency, it may have been preferable to include a strong statement of the absolute risk of pesticides in the house, rather than letting other houses in the community be the norm. There is some evidence from the comments made by the women that they did, in fact, take this comparative stance. Nonetheless, most women seemed convinced of the absolute risk—that any exposure should be avoided. Thus, presentation of community results did not seem to substantially erode the overall message of the risk communication.

The educational information given to the women concerning how best to avoid pesticide contamination in homes was quite limited. In other situations, investigators may want to devote more time and effort to education at the time of risk communication. However, in the present study, most of the women were subsequently involved in a multiyear lay health advisor intervention focused on pesticide safety and empowering women to protect their families' health.

This risk communication experience indicates that it is possible to adequately convey complex scientific findings in a way that is useful and accessible to those without a scientific background or much formal education. Low literacy of study participants should not be viewed as a deterrent to risk communication. This experience also indicates that presenting individual exposure data with reference to actual community data, rather than more abstract population-level reference data, engages community members' interest. However, investigators need to attend to participants' tendency to see their community as a norm when it may have significant levels of environmental contamination. Perhaps the best scenario would be to present research participants with comparisons of their own data with both the local community and a general population reference standard.

Communicating risk to affected individuals and communities should be an integral part of any community-based project. It is ethical to return information to the "owner" of that information. Such feedback to the community can improve the image of science and scientists. Conducting research with communities requires buy-in and cooperation from community members. Knowing that the findings will be returned to the community in a timely manner and in terms that can be understood and provide the basis for community action will increase the willingness of communities to be involved in the research process.

The process of risk communication in environmental health research should be the object of continued research. Studies in medicine have demonstrated differential comprehension and action based on how information is framed (Edwards et al. 2001). Careful evaluation of different approaches to risk communication in environmental health can be effective in identifying communication strategies that produce the greatest comprehension of information and produce health-promoting action by the public.

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