Disseminating Pesticide Exposure Results to Farmworker and Nonfarmworker Families in an Agricultural Community

A Community-Based Participatory Research Approach

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Objective: The aim of this study was to examine the impact of a dissemination process to provide individual pesticide results to study participants. **Methods:** After working with community members to disseminate data, 37 participants were recontacted via an interview survey to assess the effectiveness of the dissemination process. **Results:** Almost all participants (97.3%) recalled a home visit from a health promoter; 29 (78.4%) correctly recalled that the health promoter used a thermometer or graphic to explain the results; 26 (70.3%) correctly interpreted graphics showing high and low exposure levels in adults and 75.7% correctly interpreted results for children. **Conclusions:** The study results support the use of a community-based participatory research approach to decide how to best depict and disseminate study results, especially among participants who are often left out of the dissemination process.

Intervention studies increasingly turn to community-based participatory research (CBPR) to work with communities, especially underserved communities, on research endeavors.[1–3] One of the key principles of CBPR is that results be disseminated to all partners, including participants in the study; further, the participants should be consulted for ways to widely disseminate the findings.[1] This is antithetical to the long-standing debate on if and how individual study results should be returned to study participants.[4,5] Whereas for decades, the dissemination process focused primarily on sharing results only with the scientific community, increasingly researchers are recognizing that the publication of a scientific manuscript is only a part of the dissemination process.[6]

Along with CBPR principles, a number of researchers believe there is an ethical responsibility to disseminate research results to individual participants.[6–8] This is especially true when results may have a detrimental effect on the participant; for example, in screening tests, participants are notified if they have high glucose levels,[9] high blood pressure,[10] or a high risk of cardiovascular disease.[2] It is less clear what information should be shared when there are no known or definite sequelae to the condition being investigated. For example, it is well-known that farmworkers experience excessive pesticide exposure,[11,12] but it is less certain what chronic low levels of pesticide exposure mean to the participant. The challenge of weighing the ethical responsibility against the inconclusive information presents the researcher with a dilemma: Should one present research findings to individuals about the impact of low-dose exposure on humans, especially when the participants are unlikely to have the ability to change their environment or occupation?[7,13] From a perspective of environmental justice, it is clear that farmworkers and others exposed to pesticides are a population at risk.[14] Providing at-risk individuals with pesticide safety curricula has been shown to be effective,[15] but few studies have gone back to ascertain how long such information on pesticide safety lasts.[16] Quandt et al[7,17] reported on providing pesticide assessment to farmworkers and then evaluating a risk communication strategy.

If researchers choose to provide pesticide results to participants, other challenges also emerge. How can information be shared in lay terminology that is understandable to a population of low health literacy? When the involved participants are of low socioeconomic status, how can complex research results be made intelligible? Further, what are the best practices for disseminating research results?[18] These are some of the challenges faced when returning pesticide exposure results to low socioeconomic farmworkers and nonfarmworkers.

More importantly, however, a key scientific question is whether study participants have the right to know about biomonitoring results in a scientific study. In a study of 26 scientists involved in biomonitoring studies, the authors conclude that it is time to deliver information even when the results are toxic.[13] They acknowledge the CBPR framework as a new communication strategy to disseminate results. Ramirez-Andreotta et al[19] note that disseminating such data leads to environmental health literacy from which participants benefit.

A key scientific question of this study goes beyond the dissemination stage and seeks to examine the long-term effect of disseminating biomonitoring data of toxic pesticides. After using CBPR to disseminate urinary metabolite data on pesticide exposure, we sought to understand if participants remembered having the data disseminated and if they understood the information in the long-term. By answering these questions, we contribute to the ongoing discussion about the value of reporting back environmental assessment to study participants

METHODS

Setting

This study took place in the Lower Yakima Valley of Washington State. The area is known for its produce, particularly orchard fruits (apples, pears, and cherries), which are distributed internationally.[20] The agricultural enterprise in the Valley relies heavily on immigrant farmworkers to manage its crops. The area is a majority minority area with 69% of the residents being of Latino origin, mostly of Mexican heritage.[21] Because the area is heavily agricultural, there has been a widespread concern about the health effects of pesticides on the area's residents.[3,22,23]

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The For Healthy Kids! Project

From 1999 to the present, the Fred Hutchinson Cancer Research Center (FHCRC) has partnered with the Center for Child Environmental Health Risk at the University of Washington to examine the various pathways of pesticide exposure, the rates of pesticide exposure among farmworkers and nonfarmworkers who live in the agricultural communities, and the seasonal variability in exposure for the cohort of farmworker and nonfarmworker adults. A CBPR approach was used to engage the community throughout those years.[3,8,24] During the first 5 years, a community randomized trial established the take-home pathway as a main factor in exposure.[24] In the subsequent 10 years, we followed cohorts of farmworker and nonfarmworker families to assess specific aspects of pesticide exposure.[12] The study identified a cohort of 100 farmworkers and 100 nonfarmworkers with each family having a referent child aged 2 through 6 years of age at the beginning of the study. During these years, a number of conclusions were reached concerning the pathways of pesticide exposure and seasonal variability in exposure for farmworkers and nonfarmworkers and their children.[12,22,25] Most importantly, these studies revealed that both farmworker and nonfarmworker families alike had higher rates of pesticide exposure than seen in NHANES results.[12,26]

By 2010, the cohort size was reduced to 100 families (60 farmworker and 40 nonfarmworker) due to budgetary constraints. Because we were following a CBPR approach and because families were very interested in knowing their pesticide exposure results, we knew we had an ethical responsibility to report the results back to participants. At the time of recruitment, each participant was asked if they would agree to future contact to learn about the study findings or other research opportunities. Every family agreed to recontact. Before recontact, we worked with the Community Advisory Board (CAB) that had guided these studies since their inception, and our partners at the University of Washington to establish how results would be given to participants. Collectively, the team decided to directly inquire of the participants and the CAB regarding their preferences for receiving results.

The Town Forum

In February of 2013, we facilitated two community town forums in the Valley in both English and Spanish to discuss the collection and analyses of the biospecimens. Members of the study team presented the cumulative results of the previous pesticide exposure study (2005 to 2010) and graphics depicting the organophosphate pesticide (OP) urinary metabolite levels of dimethylthiophosphate (DMTP) found in the urine of participants compared with a national sample of urinary pesticides in participants in NHANES. DMTP is a dimethyl compound that is produced by exposure to many OPs such as azinphosmethyl and phosmet.

Using an Audience Response System (ARS), we asked the attendees of the town forum to vote on three graphics that depicted the individual urinary metabolite DMTP levels. The first was a thermometer with gradients of color (from yellow to red) and numbers depicting 10-fold increases in exposure, the second graphic was a ladder with the numbers 1 to 10 on the rungs of the ladder depicting low to high levels of exposure, and the third was a traditional pie chart showing proportions of DMTP in the urine.

Participants selected the thermometer created by the UW team (see Fig. 1) as the graphic that best depicted DMPT levels. As experts in toxicology, risk assessment, and risk communication, UW

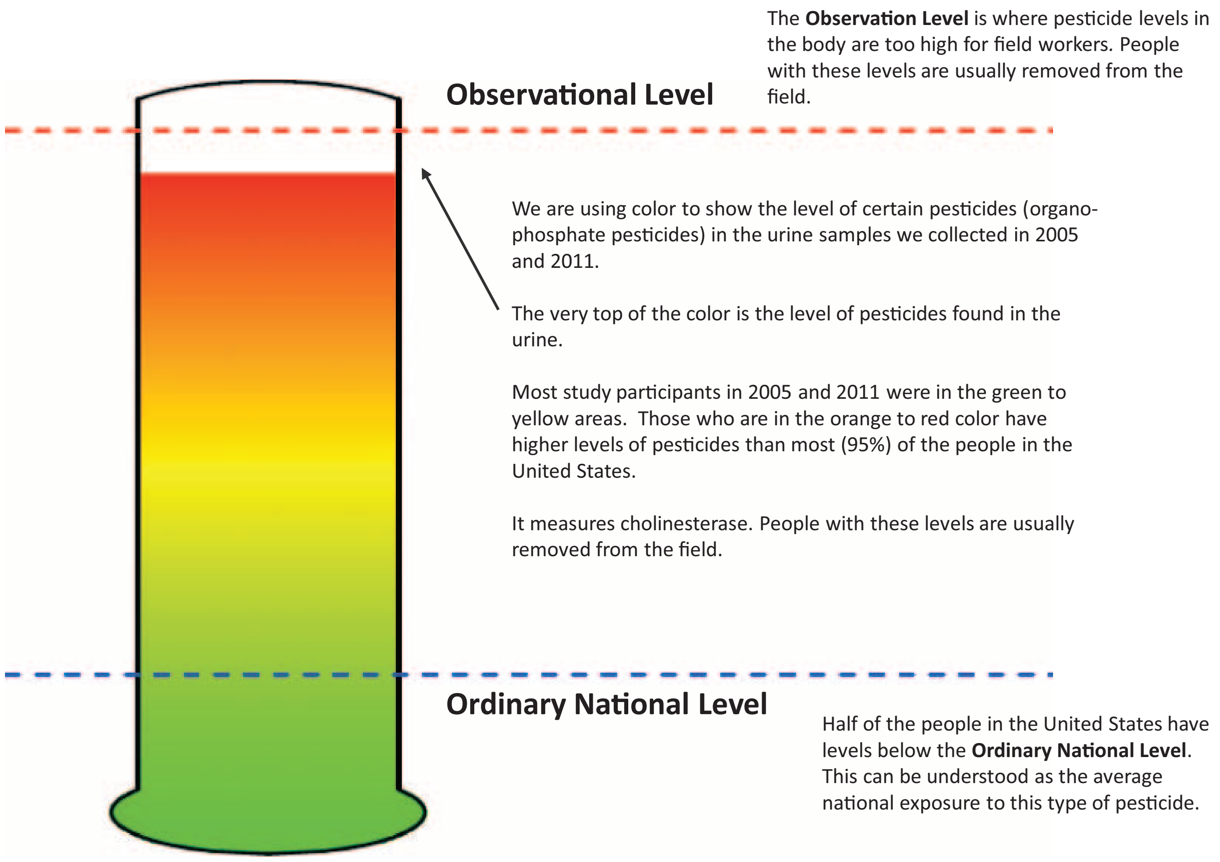

FIGURE 1. Thermometer explaining pesticide results.

staff worked together to create a simplistic thermometer for the purpose of providing results to participants. The thermometer used for the town forum had numbers 1 to 10 on it and had a gradient of color: green for low, yellow to orange for medium, and red for high exposure. Reaction from the town forums' participants indicated that the numbers were very confusing to community members. For example, a change from 1 to 2 was a 10-fold change in exposure, yet participants interpreted this change as a very small incremental change, raising many questions about the DMTP levels. When we redirected them to the color gradation, attendees were able to better understand the graphic. Thus, the team decided to use the thermometer without the numbers. The final thermometers also contained the level of ''average'' exposure, which was the NHANES results for exposure and a level that symbolized when workers would be asked to leave the field because of high cholinesterase levels. We used regression analysis of urinary DMTP and AChE inhibition in blood to estimate level of urinary DMTP, which indicated AChE inhibition of 20% or greater. Therefore, we described ''the observation level'' as the level where AChE inhibition would trigger further observation of AChE until workers' AChE level returned to values with less than 20% inhibition. In Washington state, a depression of AChE 20% or more from an agricultural pesticide handler's personal baseline requires the employer to take actions for employee safety, including conducting work practice investigation for possible routes of exposure and removing the employee until his/her AChE levels are within 20% of the personal baseline.[27] The urinary DMTP shown in the thermometer is the maximum of three values of urine samples collected within the thinning and the nonspray season.

Once the team and participants agreed on the figure, individual DMTP results were calculated for each adult and referent child who participated in the study. Participants received results for two 5-year periods: the 2005 to 2010 study and the 2011 to 2015 study. Thus, the families could compare their levels over time.

Returning Results

Of the 100 families who participated in 2011, we were able to successfully locate and provide individual study results to 91 families in 2015. We determined, based on interviews with participants, that a personal visit to each family was appropriate so that recipients could ask and receive answers to their questions. To do so, we enlisted our five community health promoters (*promotores*) who had previously visited the families to collect the samples and the questionnaires. Because these *promotores* had built a good rapport with the families, we thought it important to maintain those connections.

We created a training manual for the five community health promoters on our staff who would be recontacting participants and providing the individual results to each one in their home. *Promotores* received a full-day training on how to explain the results and how to answer questions regarding the study and results. In addition, we identified a number of materials on protection from pesticide exposure that *promotores* would give to the participants. These materials ranged from an Environmental Protection Agency-sponsored *fotonovela* to simple tip sheets on how to recognize symptoms of pesticide exposure.

A promotor/a went to each of the 91 homes. Using the visual of the thermometer, they presented information about the individual urinary metabolite of DMPT to the participant and the referent child. In addition, they presented information about how the individual's level compared with NHANES. They also noted the levels at which farmworkers would be withdrawn from the field due to excessive levels of pesticide in the urine. Finally, they provided and gave materials on things individuals could do to protect themselves and their children from pesticide exposure.

Understanding the Information

We wished to determine whether participants understood and recalled the information we had given them. Thus, 9 months after the dissemination of results, *promotores* recontacted a 40% random sample of the 91 participants to whom information was disseminated. A total of 37 participants stratified by farmworker or non-farmworker status (24 farmworkers and 13 non-farmworkers) were contacted to ascertain their impressions of the information dissemination. *Promotores* administered a face-to-face interview survey in which participants were asked a number of questions about how the data were presented (Did they remember the data? Did they remember a promotor/a coming to the home? Did they understand what the thermometer meant?). They were also asked to interpret two sample thermometer results (one adult, one child) (What did the thermometer mean? Was the farmworker at risk? Was the child at risk?). Finally, they were asked about the materials that were provided, about protective practices, and their sociodemographic characteristics (Did they remember the materials? Did they read them? Did they share them?).

Data Presentation

Participants were asked whether they recalled a *promotor/a* coming to the home. If they responded ''yes,'' they were asked whether the *promotor/a* talked about pesticide exposure. They were then asked what the *promotor/a* used to describe the results. *Promotores* then showed respondents two thermometers, one for an adult and one for a child, and asked participants to explain what the data meant. Response categories were: ''high levels of pesticide exposure,'' average levels of pesticide exposure,'' or none or little pesticide exposure.''

Promotores then asked respondents a series of ''yes/no'' questions about the materials that had been distributed. Specifically, they were asked if they remembered receiving the materials, if they had read the material, whether they referred to it when they had questions about pesticides, and whether they shared the material with others such as family members or physicians.

Finally, participants were asked to respond with ''true'' or ''false'' to a series of statements about pesticide protective practices. Practices included items such as ''It is safe to walk through a field that was recently sprayed with pesticides'' and ''Vacuuming carpets regularly can reduce children's exposure to pesticides.''

RESULTS

All 37 participants who were recontacted responded to the survey. Table 1 presents the sociodemographic characteristics of the

TABLE 1. Characteristics of the Participants ($N = 37$)

Characteristic	Farmworker ($N = 24$)	Nonfarmworker ($N = 13$)	Total ($N = 37$)
Percent female	21 (87.5)	11 (84.6)	32 (86.5)
Age, years			
25–40	16 (66.7)	7 (53.8)	23 (62.2)
>40	8 (33.3)	6 (46.2)	14 (37.8)
Marital status			
Married/Living as married	18 (75.0)	10 (76.9)	28 (75.6)
Other	6 (25.0)	3 (23.1)	9 (24.3)
Income			
<$15,000	7 (29.2)	4 (30.8)	11 (29.7)
$15,000–$25,000	5 (20.8)	1 (7.7)	6 (16.2)
$25,001–$50,000	12 (50.0)	8 (61.5)	20 (54.1)
Language spoken			
Only/Mostly Spanish	17 (70.8)	6 (46.2)	23 (62.2)
Other	7 (29.2)	7 (53.8)	14 (37.8)
Health insurance			
Yes	2 (8.3)	2 (15.4)	4 (10.8)
No	22 (91.7)	11 (84.6)	33 (89.2)

TABLE 2. Response to Levels of Exposure* ($N = 37$)

	Farmworker				Nonfarmworker			
	Adult		Child		Adult		Child	
Response About Level	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)
High levels of exposure	16	(66.7)	1	(4.2)	10	(76.9)	2	(15.4)
Average levels of exposure	7	(29.2)	3	(12.5)	1	(7.7)	3	(23.1)
None or little exposure	1	(4.1)	20	(83.3)	2	(15.4)	8	(61.5)

*Correct responses are Adults—High levels of exposure; Children—None or little exposure.

respondents. The majority of participants were female and aged 25 to 40 years. Language spoken varied by occupation, with more nonfarmworkers speaking English than farmworkers. Sample respondents were unlikely to have health insurance.

All but one respondent remembered that a *promotor/a* had visited them the past summer, and when asked what the *promotor/a* talked about, almost all (97.3%) remembered that the topic of discussion was pesticides. When asked what was used to describe the results, 29 (78.4%) remembered that it was a thermometer, three (8.1%) said it was a ladder, four (10.8%) said it was ‘‘other,’’ and one (2.7%) did not remember (data not shown).

Table 2 summarizes the respondent's interpretation of the thermometers that were included in the questionnaire. The correct response for adults was that there were high levels of exposure and 70.3% were correct. For children, there was little exposure and 75.7% reported that correctly. Nonfarmworkers were slightly more likely to provide correct answers; however, the numbers were too small for significance to be achieved.

Table 3 notes whether the participant remembered receiving the materials, reading them, referring to them, and sharing the materials with family, friends, or doctor. Overwhelmingly, the participants remembered receiving the materials, the majority read the materials, a smaller percentage referred to the materials, and about two-thirds shared the materials with others. There were few differences between farmworkers and nonfarmworkers, although the latter were more likely to recall receiving the materials (data not shown).

Table 4 summarizes the responses to the protective practices. The overwhelming majority knew all the correct answers to the protective practices.

DISCUSSION

Using a CBPR approach, we sought to gain participants' opinions on how pesticide exposure data should be disseminated, and then implemented the dissemination procedures to the 91 farmworkers and nonfarmworkers who had participated in the 10-year study on pesticide exposure among adults and children living in an agricultural area. From a subsequent sample of 37 of the 91 participants, we were able to approximate how participants understood the data and how they used materials on pesticide protection that were distributed during the dissemination implementation. Overwhelmingly, participants remembered being visited for information dissemination, and participants were able to correctly assess pesticide exposure in sample charts given to them. Further, the vast majority of the respondents reported reading and using the materials that were distributed, and indicated, through their responses to protective practices, that they knew how to protect themselves and their families from pesticide exposure.

Presenting data such as pesticide metabolites in the urine or dust residues in the homes of farmworkers is a difficult task.[5,7,19] The data are not easily understood and making them simple to understand by the layperson is challenging. This is especially challenging for immigrants who work in agriculture; in general, they have low literacy levels, low educational levels, and frequently are monolingual Spanish speakers. We were fortunate to have resources to convene a sample of participants—both farmworkers and nonfarmworkers—to discuss how the data should be conveyed. The participants in the forum were unanimous in their response that a thermometer (see Fig. 1) would allow them to see where their urinary metabolite levels were relative to the larger US population as shown in NHANES. Because of their input, we were able to show each participant where they fell in terms of exposure. Moreover, a sizeable proportion of the participant evaluation sample was able to correctly identify the level of urinary metabolites in sample thermometers that we showed them, indicating that most of the participants understood the data.

Less clear is whether the participants understood the relative risk of the data they received. Indeed, pesticide exposure has few national standards and it is difficult to know what action should be taken if one has ‘‘high’’ levels of urinary metabolites. However, by using the thermometers, we were able to compare participant levels to those found in NHANES so the lower threshold of exposure was shown. Nevertheless, it remains problematic to understand at what

TABLE 3. Response to Materials Disseminated ($N = 37$)

Material	Received it	Read it	Referred to it	Shared it
Percent responding ‘‘yes’’				
Comic book	31 (83.8)	26 (70.3)	20 (54.1)	23 (62.2)
Protecting our future	34 (91.9)	32 (86.5)	26 (70.3)	24 (64.8)
Pesticide poisoning	31 (83.8)	30 (81.1)	27 (72.9)	24 (64.8)
Brochure on pesticides	30 (81.1)	28 (75.7)	22 (59.5)	23 (62.2)

TABLE 4. Protective Practices ($N = 37$)

Practice	True	False
It is safe to walk through a field recently sprayed with pesticides (False)	0 (0.0)	37 (100%)
It is okay to bring agricultural pesticides home and use them at home (False)	0 (0.0)	37 (100%)
Household sprays like RAID and other insect repellents have pesticides (True)	33 (89.2%)	4 (10.8%)
Washing fruits and vegetables before eating them reduces exposure to pesticides (True)	37 (100%)	0 (0.0)
Vacuuming carpets regularly can reduce children's exposure to pesticides (True)	36 (97.3%)	1 (2.7%)
Washing floors regularly can reduce children's exposure to pesticides (True)	36 (97.3%)	1 (2.7%)

point one should be concerned enough about pesticide exposure that action should be taken. And further, what action? In Washington State, farmworkers may be removed from the field if acetylcholinesterase levels are unduly high, but the urinary metabolites do not assess that. In addition, blood levels of acetylcholinesterase are not normally collected from farmworkers. Thus, it is difficult to know what signifies a ‘‘too high’’ level.

Partially to address this issue, we disseminated materials to all the participants to tell them the strategies that could be used to protect them and their families from pesticide exposure. These materials were written in a manner to make them easy to understand and were available in both English and Spanish. The strategies included activities such as leaving boots and caps outside the home, not holding children immediately after work but waiting until one had changed clothes and showered, washing work clothes separately, not entering a field that had been recently sprayed with pesticides, and so on. We also distributed materials that noted pesticide poisoning for both high-level and low-level exposure. These materials were read by a high proportion of participants, and were shared with many others. In addition, the responses to a section on protective practices were very accurate, suggesting participants understood the materials.

Increasingly, researchers are cognizant of the need to present data back to participants, especially participants in trials wherein biological measures are taken. Noting that dissemination through scientific publication is unlikely to reach either the participants of a research study or the community within which they live, many have argued that researchers have the ethical responsibility to study participants to provide them with their results.[4,19,23] Others have noted that this is especially relevant for the return of environmental sample data.[7,19] Nevertheless, returning complex results to lay people can be challenging.[7] Despite the challenges, we have attempted to disseminate individual results throughout our studies on pesticide exposure. Our opportunity to return to a sample of participants gave us confidence that the dissemination of data was a worthwhile process. The participants were able to explain the results back to us, indicating that they understood the results. Further, they read, referred to, and shared pesticide protection materials. This lends credence to the importance of fulfilling the ethical imperative of dissemination of biological results to participants.

Limitations

Although we attempted to involve participants in the process of returning results to them, resources allowed us to only go back to 37 of the 91 participants who received the results. Thus, the sample size is relatively small. However, others have reported results from similar sized samples.[7] Further, rather than having participants totally self-report the meaning of the thermometer examples, we gave them close-ended options; this may have led to some bias. The overwhelming majority of our farmworkers were female; this may have been because we required the farmworker to have a referent child. In addition, however, the thinning farmwork (picking buds and small fruit to give the fruit room to grow) is disproportionately done by women. Finally, we appreciate the difficulty of trying to explain what should be done to reduce personal pesticide exposure; however, we provided a number of materials to help participants protect themselves and their families from pesticide exposure.

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