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W. Kent Anger PhD , Lindsey Patterson BA , Martha Fuchs BS , Liliana L. Will MS & Diane S. Rohlman PhD

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Learning and Recall of Worker Protection Standard (WPS) Training in Vineyard Workers

W. Kent Anger, PhD
Lindsey Patterson, BA
Martha Fuchs, BS
Liliana L. Will, MS
Diane S. Rohlman, PhD

ABSTRACT. Worker Protection Standard (WPS) training is one of the U.S. Environmental Protection Agency's (EPA) primary methods for preventing pesticide exposure in agricultural workers. Retention of the knowledge from the training may occasionally be tested by state Occupational Safety and Health Administrations (state OSHAs) during a site visit, but anecdotal evidence suggests that there is no consistent testing of knowledge after WPS training. EPA's retraining requirements are at 5-year intervals, meaning the knowledge must be retained for that long. Vineyard workers completed a test of their baseline WPS knowledge, computer-based training on WPS, a post-test immediately after training and a re-test 5 months later. Pre-test performance suggested that there was a relatively high level of baseline knowledge of WPS information on two-answer multiple choice tests (74% to 75%) prior to training. Training increased the knowledge to 85% on the post-test with the same questions, a significant increase ($p < .001$, 1-tailed) and a large effect size (d) of .90. Re-test performance (78%) at 5 months revealed a return towards but not back to the pre-test levels. Better test performance was significantly correlated with higher education and to a lesser extent with younger ages. Whether this level

W. Kent Anger, Lindsey Patterson, Martha Fuchs, Liliana L. Will, and Diane S. Rohlman are affiliated with Oregon Health and Science University, Center for Research on Occupational and Environmental Toxicology, Portland, Oregon, USA.

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Conflict of Interest Statement: Dr. Anger and Dr. Rohlman are the inventors of the cTRAIN system and 9BUTTON used in this study. This could result in financial benefit for them and OHSU if this study and others like it produce useful results. Drs. Anger and Rohlman also have a company, NwETA, that could benefit if this study and others like it produce useful results. This potential conflict has been reviewed and managed by OHSU and the Integrity Program Oversight Council. For more information, contact the OHSU Research Integrity Office at 503-494-7887.

Address correspondence to: W. Kent Anger, PhD, Oregon Health and Science University, Center for Research on Occupational and Environmental Toxicology, 3181 SW Sam Jackson Park Road, L606, Portland, OR 97239, USA (E-mail: anger@ohsu.edu; Phone: 503-494-2512).

of knowledge is sufficient to protect agricultural workers remains an open question, although an increase in the proportion of people in a work group who know the critical WPS information may be the most important impact of training.

KEYWORDS. Agriculture, CBPR, community-based participatory research, computer-based training, Latino, training, Worker Protection Standard, WPS

INTRODUCTION

The Environmental Protection Agency's (EPA) Worker Protection Standard (WPS) is designed as a primary prevention method. Agricultural employers are required to provide WPS training to all employees within the first 6 days of beginning work. The main topic of this training is pesticides: Where pesticides are found, hazards, entry routes, signs and symptoms, how to obtain emergency medical care, drift, chemigation, residues, containers, and reducing or minimizing exposures.¹ The goal is to minimize pesticide exposures, and there is evidence that following some WPS recommendations (e.g., wearing proper gloves) does reduce exposures.²

WPS training is required at the beginning of employment, and then every 5 years,¹ although updated requirements are reportedly in discussion (personal communication, E. Evans, Environmental Protection Agency). In order to meet the WPS requirements, a knowledgeable trainer is required to be present during the training to answer questions. Workers are expected to retain the training for up to 5 years, and employers are required to maintain a standardized poster describing the key WPS information in a primary gathering place of all workers (or a location where all workers will see it). The poster is printed in both English and Spanish, the primary language of most agricultural workers at present, although only one language may be posted.

Surveys and interviews of agricultural workers suggest that many workers do not receive WPS training, or do not remember receiving it. For example, Shipp et al.³ found that only 21% of 324 farmworkers surveyed in south Texas reported ever receiving training about pesticides. In another sample of migrant farmworker mothers, 46% reported such training.⁴ Arcury et al.⁵ indicated that only 35% of farmworkers reported

ever receiving information or training about pesticides (only 26% reported receiving training during the current season). However, results of an objective test of pesticide knowledge drawn from the WPS suggested that farmworkers could answer such questions at a fairly high rate (78%), and scores were correlated with self-reported prior WPS training.⁶

Quandt et al.⁷ developed a community-based approach to educating farmworkers about pesticide exposures, "or designing a health intervention where diverse social, cultural, political, and regulatory issues affect farmworkers' risk of exposure." Our intervention is community-based participatory research (CBPR)⁸⁻¹⁰ that took a similar approach, although we employed a computer-based training solution as the most economical approach for agricultural workers, long term. Because current U.S. farmworkers have a mean education in the range of 5 to 7 years (e.g., references 11 and 12), we selected a computer-based training system that had been developed and used with this target population.^{11,13}

We addressed three questions in this study: (1) Prior to training, would farmworkers demonstrate knowledge of the WPS information that was above chance responding, confirming McCauley et al.⁶? (2) Would computer-based training on WPS improve the farmworkers' knowledge from baseline? (3) Would the trainees recall the information after 5 months?

METHODS

Participants

Workers ($N = 61$) were recruited from seven vineyards in northwest Oregon to participate in a study on Worker Protection Standard (WPS) training. We requested, but could not confirm, that

a flyer or verbal description of the volunteer opportunity be given to all workers available for an hour to participate in training on a computer. All participants identified themselves as Hispanic and all reported that they were born in Mexico. By far the largest number of participants identified their job title as a variation on *trabajador* (worker) or *en el campo* (fieldworker), but other job titles included tractor driver, operations manager, crew foreman, and supervisor. Self-reports indicated that the mean years holding their jobs ranged between 4.8 and 6.5 years in these workers drawn from the year-round worker pool of the vineyards, and the mean years the participants had lived in the United States was 10.8 to 12.6. Participants were compensated \$35 for participation.

As noted in Table 1, 61 participants completed the pre-test and the training (to answer question 1), 52 completed the pre-test, training, and the post-test (to answer question 2), and 26 of the 52 also completed the re-test approximately 5 months later (to answer question 3). The latter number is low because only 37 participants were invited to participate in the re-test study (70% of the sample returned for the re-test). Additional participants from three vineyards who had been given the training during the course of the re-test study were included to provide a larger and thus more representative sample of pre- and post-test performance.

The time between training and the re-test was a mean of 4.9 (SD = 0.5) months; the range was 4.5 to 5.6 months, in order to accommodate vineyard work schedules. The interval is rounded to 5 months in this report. The demographics of the 61, 52, and 26 participant subgroups did not differ substantially. The mean age ranged from 30.7 to 35.0 years, education ranged from 0 to 16 years, with a mean of 6.3 to 6.7 years, and their gender was predominantly male. Four of the

61 and 2 of the 52 identified their primary language as English, and took the training in English, whereas the rest identified Spanish as their primary language and all but one took the training in Spanish (the other took the test in English).

Training Content

The WPS training content was presented using cTRAIN 2.0 computer-based training software (NwETA; Lake Oswego, OR). The structure of cTRAIN is based on principles of behavioral psychology, including (1) self-pacing and interactivity (frequent quizzes, immediate feedback, high accuracy criterion); (2) clear user instructions, requiring little coaching in order for students to use the training; (3) icon-based navigation cues always on-screen, making it unnecessary to need to remember how to move about; (4) pictures and/or a movie on all screens; and (5) spoken-language option selectable on each screen. The software format was developed for blue collar workers,¹⁴ and the user instructions were developed through serial pilot testing in noneducated agricultural workers.¹³ This software has been used to teach ladder safety to orchard workers, who rated it very positively, providing evidence of significant knowledge and work practice changes in a work group similar to the target audience of this research.¹¹ To optimize the environment, especially for participants with limited education, the 9BUTTON was used for response input (depicted in Figure 1).

Training content was based on the training requirements in the EPA manual, *How To Comply With the Worker Protection Standard For Agricultural Pesticides: What Employers Need to Know*.¹ Topics covered in the WPS training were Hazard communication, places

TABLE 1. Mean (SD) Participant Age, Education, and Gender Characteristics

Completed	N	Age	Years of education	Gender	Years in job	Years lived in U.S.
Pre-test	61	35.0 (9.6)	6.6 (3.1)	M = 56; F = 5	6.1 (5.3)	12.3 (5.8)
Pre-, Post-test	52	34.2 (9.1)	6.7 (2.6)	M = 49; F = 3	6.5 (5.6)	12.6 (5.8)
Pre-, Post-, Re-test	26	30.7 (8.8)	6.3 (2.1)	M = 25; F = 1	4.8 (4.8)	10.8 (6.1)

FIGURE 1. Participants completing WPS re-test using 9BUTTON response unit.



hazardous chemicals are found, hazards posed by agricultural chemicals, special hazards to children, chemical container labels, signal words, material safety data sheets (MSDSs), Global Harmonization System (GHS), required signs, re-entry interval (REI), special dangers of enclosed spaces, WPS poster, and precautions. There were 49 screens of information and 15 quiz questions in the training. These were divided into 10 ‘infosets,’ which in the terminology of the training program were similar to sequential building blocks, each of which must be completed before moving on to the next building block (infoset). Infosets consisted of 2 to 11 screens of information followed by 1 to 3 quiz questions on the preceding information; all screens in an infoset were repeated in the event of an error. The pre-test, post-test, and re-test had the same 38 questions, although the answers were in a different order in the different tests. The training had previously been pilot tested with vineyard workers, and changes were made to the test questions and answers as well as the training text based on their input.

Procedures

Participants were recruited orally and signed an institutional review board (IRB)-approved consent form prior to beginning the training. Depending on the size of the group, between 5 and 15 laptop computers were set up on tables in small conference rooms or tasting rooms at the vineyards and overseen by two research

staff. Participants were instructed to press a button to begin the training, which began with a brief tutorial on how to use the software. Staff remained in the room at all times to answer questions. The most frequent question was why they kept answering the same question (repetition of the information and the quiz question occurred when they gave the wrong answer, plus they had the same questions in the pre- and post-tests). The pre- and post-tests were completed on the computer as part of the computer-based training, as was the re-test given 5 months later in the same setting.

Analysis

The test results are reported as mean (SD) percent correct. Differences between test periods were analyzed by *t* test, and the nonparametric signed rank test, which is unaffected by outliers, was also used when the distribution of scores was not normal or when there was a significant outlier. Effect size (*d*) is also reported to characterize the degree of change against the variation (standard deviation) in the distribution.¹⁵ Spearman’s *r* correlation was used to explore associations.

RESULTS

Test Performance

The mean percent correct on the pre-test was 75% (SD = 8.5) in the 61 participants who completed the pre-test. For the 52 participants who completed the training, performance improved

from 76% (SD = 8.4) on the pre-test to 85% (SD = 10.1) on the post-test. This difference was significant $t(51) = 6.41$, one-sided p value $<.001$; the effect size (d) is .90. The nonparametric signed rank test reported $V = 1121$, a one-sided p value of .001, confirming the t test.

For the 26 participants who completed the initial training and the re-test 5 months later, performance on the 5 month re-test (mean = 78%; SD = 10.1) remained significantly above pre-test (75%) performance ($V = 192.5$, two-sided $p = .033$; signed rank test); however the effect size (d) was .36. Consistent with this difference, the 78% performance on the re-test did not differ significantly from post-test performance (81%, SD = 7.3) immediately after training (signed rank test $V = 84.5$, two-sided $p = .11$), and the effect size ($d = .33$) was smaller. The signed rank test was used because the performance of one participant declined precipitously on the re-test. That the post-test performance of the group of 26 completing the re-test (81%) was well below that of the larger group of 52 (85%) could not be readily explained.

For the 26 participants who completed the pre-, post-, and re-test, test performance scores correlated (Spearman r) significantly (two-sided) with reported years of education completed, but not with age (Table 2). Poorer performance was associated with lower education.

Item-by-Item Responses

The knowledge test used for both pre- and post-tests consisted of 38 questions. The individual answers of the 26 participants who completed the pre-test, post-test, and re-test at 5 months were examined. The questions can be categorized as those that were answered correctly by most or many participants, including on the pre-test, and those on which participants either learned

or did not learn the correct answers. These are detailed next.

Most Questions Answered Correctly on All Three Tests

Most (at least 88%) participants answered 12 of the questions correctly on the pre-, post-, and re-tests (the question correct and answer are combined below):

- ‘toxic’ means hazardous to your health
- a pesticide is a chemical that kills pests
- irrigation water may have pesticides in it so they shouldn’t drink it
- pesticide drift is likely to result in exposure
- a sign is posted when pesticides have been sprayed in a field
- if eyes get a pesticide in them, rinse them for 15 minutes
- if sick and think it is due to pesticide exposure, take a pesticide label and go to hospital
- if pesticide gets on their skin, take off their clothes and rinse their skin
- wearing gloves and clothes that cover the skin can prevent pesticide residue exposure
- removing work boots before walking in a house can prevent pesticide transfer
- shower as soon as they get home from work before making contact with anyone
- they can work safely with pesticides if they take proper precautions

Many (75% to 85%) participants answered seven questions correctly on all three tests:

- sweating ‘a lot’ is a sign of pesticide over-exposure
- go to a hospital immediately if they think they may be sick due to a pesticide exposure

TABLE 2. Correlations Between Test Performance and Age and Education, and Two-Sided Probability Levels on Pre-, Post, and Pre-Test Minus Post-Test

	Pre-test	Post-test	Post- minus Pre-test
Age	$r = -.049$ ($p = .74$)	$r = -.0043$ ($p = .97$)	$r = -.003$ ($p = .98$)
Education	$r = .36$ ($p = .01$)	$r = .48$ ($p = .01$)	$r = .03$ ($p = .01$)

- boss required to give pesticide label information if worker is exposed to a pesticide
- an unborn baby is less protected from pesticides than is the mother
- skin sensitization means becoming more sensitive to a pesticide after an exposure to it
- pesticide labels contain information on legal/allowable uses of pesticides
- employer required to provide soap and water if pesticides are being sprayed in an area

The responses to the other questions can be divided into three groups: A chance (50%) number of participants answered the questions correctly on the pre-test, but most answered correctly on the post-test (information learned); few answered correctly on the pre-test, post-test, or re-test (the training failed); chance performance was seen on the pre-test but most answered incorrectly on the post-test and re-test (i.e., training failed, it led them to change to the wrong answer). These questions are listed below.

Chance on Pre-test, Correct on Post-test (Information Learned)

Following chance correct answers on the pre-test, answers to six questions were correct at the post-test and remained correct (survived) to the re-test, whereas answers on four questions were correct at the post-test but did not survive until the retest.

Information learned that *did* survive to the re-test:

- find the phone number of the nearest hospital on the WPS poster
- chronic toxicity is due to exposure for months or years
- pesticide residue remains on the crop for several hours or days
- some people eliminate pesticides slowly while others eliminate pesticides quickly
- OR OSHA requires MSDSs to be provided to workers within 24 hours of a request
- pesticide mixer has a more elevated risk of pesticide exposure than a farm manager

Information learned that *did not* survive to the re-test:

- call for help if you see someone down in an enclosed space such as a greenhouse
- the forehead is more sensitive to pesticide exposure than the back
- small pupils are an indicator of pesticide exposure, versus large pupils
- wash hands before using the toilet when around pesticides (our answers were poorly written on this question and may explain the results)

Low Percent Correct that Didn't Change (Training Failed)

- it is safe to work where pesticides are being applied if workers are not sprayed directly
- children are at risk of pesticide exposure due to their developing brain
- the pesticide label is a better source of pesticide poisoning information than a first aid book the supervisor may have
- some people are more sensitive to pesticides than others
- an MSDS has information on pesticide hazards
- all pesticides degrade into safe substances

Chance on Pre-test, Wrong on Post-test (Training Led to the Wrong Answer)

- REI is the time people are prohibited from entering a field after a pesticide application
- wash work clothes separately from home clothes (although this recovered at 5 month re-test)
- never take pesticide containers home as there may be residue (recovered at 5 month re-test)

Training Experience and Reaction (Rating) Measures

The 52 participants who took the pre-test, training, and post-test completed reaction (rating) questionnaires.¹⁶ Of this sample, 68% reported they had received safety or job training 'almost never' or 'sometimes.' Of the 52 participants, 60% reported that they had never taken safety

or job training on a computer, although this percentage increases to 92% if the participants in a separate experiment in which they did receive computer-based training (noted above) are included in the calculation. The 52 workers reported that they had been working in their jobs for a mean of 4.8 years, and their report of the frequency of safety training did not correlate with years on the job ($r = .36$).

Reaction measures revealed that 94% of participants thought the training was 'excellent' or 'good,' but none rated it 'not very good' or 'deficient.' Most participants (88%) reported that the training was 'much better' or 'better than other training' they had received. Interestingly, their expectations of the training were not high, with 5% expecting the training would be 'not as good as previous training' and 27% expecting it would be 'equal' to other training (the type of previous training was not specified in the questions). In terms of practicality or usefulness, 94% rated the training 'extremely useful' or 'very useful.'

DISCUSSION

Test Performance

The pre-test performance of 75% correct by the larger sample of 61 participants was well above chance (50%), suggesting that participants began the training with some knowledge of the Worker Protection Standard. This is encouraging as it suggests that the original WPS training (which we did not attempt to verify) and interactions with fellow employees and family provided participants with basic pesticide safety knowledge. Thus, the vineyards had met their requirement to train their workforce, although lay information may have contributed to their knowledge.¹⁷ However, that the mean percent correct on the pre-test was 75% also indicates that there many were people below that percent correct and their knowledge base must be considered insufficient. Thus, it would appear prudent to provide WPS refresher training periodically. Based on our re-test at 5 months, where there was performance loss (from 81% back to 78%), the current 5-year interval between re-training required by EPA¹ is too long.

Practical Importance

In practical terms, and considering the 26 participants who completed all 38 questions on all three tests, the 75% to 81% correct test performance increase represents an increase from 28 correct answers on the pre-test to 30 correct, and falling back to 29 correct at the re-test. In real-world terms, this might not appear to represent a sufficient addition in knowledge to justify the time commitment and expense of the training. Of course, where serious safety concerns are involved, any increase in knowledge is important as the one answer a person remembered could be where to find the phone number of the nearest hospital (on the WPS poster).

Perhaps a better way of evaluating the training is in the item analysis, which indicates that the training improved knowledge of dangers of enclosed spaces such as greenhouses, the forehead is a sensitive area for pesticide exposure, small pupils are an indicator of pesticide exposure, to wash your hands before using the toilet when around pesticides, where to find the phone number of the nearest hospital, the concept of chronic toxicity, that residue remains on the crop for up to several days, that OR OSHA requires MSDSs to be provided to workers within 24 hours of a request, and that a pesticide mixer has an elevated risk of pesticide exposure (and the latter five items survived for 5 months to the re-test). These are arguably among the most important items of information in the WPS. Román-Muñiz¹⁸ found that coworker training was a significant influence in a Latino group, and likely in any workgroup. Thus, increasing the proportion of people in a work group who know this information may be the most important practical impact of the present training, so that at least one person remembers the critical information when a pesticide over-exposure occurs.

Comparisons with Meta-Analyses

As has been seen in other research,¹¹ an agricultural workforce with limited education can complete and learn from computer-based training. The knowledge increase following our WPS training, though modest, was statistically

significant and the effect size (d) was .90. Cohen¹⁵ considers this to be a large effect size (d above .8). By comparison, the Burke et al.¹⁹ meta-analysis of 95 occupational safety and health training studies in peer reviewed publications between 1971 and 2003 revealed a mean effect size (d) of .74 for moderately engaging training such as computer-based training and $d = .55$ for less engaging methods such as brochures. Whether the groups in the Burke meta-analysis had limited education of the level in the present population (mean 6.3 to 6.7 years of education) is unknown but doubtful. Arthur et al.'s²⁰ review of the larger training literature revealed a mean effect size of .63 for learning/knowledge from 162 different studies, well below the $d = .90$ in the present study. Thus, based on the effect size, the training provided in this case is superior to the mean effect size produced by other similar methods.

Comparisons with Other WPS Research

The knowledge at pre-test can be compared to the findings of McCauley et al.⁶ who used a 20-question test. The test was given primarily orally in small groups of agricultural workers who answered by filling in a questionnaire form. The overall mean correct responses was 78.4% (15 correct of 20), remarkably similar to our 75% for a very similar but arguably more challenging set of questions. McCauley had pilot tested a more extensive scale of 40 questions but concluded that it was too long for the population, an assertion that the present results would appear to contradict given the positive reaction to our training that included *both* a pre-test *and* a post-test of 38 items.

Reaction Measures

The training was well received by the participants. The overall 'grade' of the training was characterized as 'excellent' or 'good' by 90% of the participants, and none considered it 'not very good' or 'deficient.' The reaction measures indicating that the participants liked the training gives some confidence that the participants found the information worth learning and that they were engaged in the task. This is one reason to include measures of reaction, one of

Kirkpatrick's¹⁶ four basic measures of training effectiveness (along with knowledge, behavior, and results), in any training.

It is likely that the positive reviews as well as the performance improvement were due in part to the careful design of the training, piloting it with the target audience, training software and user instructions that had been developed in and for an agricultural workforce,¹³ and possibly to the 9BUTTON response input device designed for computer novices with limited education.²¹ Such steps are recommended when developing new training content and training technology for a population with limited education such as the U.S. agricultural workforce. It should also be said that the positive response to training program is likely due in part to the rarity of training in Spanish.

CONCLUSIONS

Vineyard workers with a mean of 6.3 to 6.7 years of education began Worker Protection Standard (WPS) training with a relatively high pre-test knowledge of WPS information, indicating a high degree of knowledge in the agricultural workforce sampled in this study. The mean post-test performance increased from 76% to 85%. Although this was only a modest increase of 1 to 2 correct responses out of 20 answers, the improvement was statistically significant ($p < .001$) and the effect size was large ($d = .90$). When retested a mean of 5 months later on the same questions, performance declined to 78% correct performance, which remained above pre-test levels but was nonetheless a decline from the post-test score. This research suggests, as have reports of others (e.g., reference 22), that more effective interventions are needed to improve pesticide safety knowledge, and that those interventions should involve the occupational community that is the target audience for the training. Training interventions in agricultural populations with limited education can employ technology, as in the example seen here. Whatever the intervention method chosen, WPS training needs to be frequently updated.

REFERENCES

1. EPA. How To Comply With the Worker Protection Standard for Agricultural Pesticides: What Employers Need to Know. In: Agency EP, Office of Prevention, Pesticides, and Toxic Substances (MC 7506C) (editor).: *Environmental Protection Agency*; 2005:1–127.
2. Bradman MA, Harnly ME, Draper W, Seidel S, Teran S, Wakeham D, Neutra R. Pesticide exposures to children from California's Central Valley: results of a pilot study. *J Expo Anal Environ Epidemiol*. 1997;7:217–234.
3. Shipp EM, Cooper SP, del Junco DJ, Bolin JN, Whitworth RE, Cooper CJ. Pesticide safety training among farmworker adolescents from Starr County, Texas. *J Agric Saf Health*. 2007;13:311–321.
4. Shipp EM, Cooper SP, Bureau KD, Bolin JN. Pesticide safety training and access to field sanitation among migrant farmworker mothers from Starr County, Texas. *J Agric Saf Health*. 2005;11:51–60.
5. Arcury TA, Quandt SA, Austin CK, Preisser J, Cabrera LF. Implementation of EPA's Worker Protection Standard training for agricultural laborers: an evaluation using North Carolina data. *Public Health Rep*. 1999; 114:459–468.
6. McCauley LA, Shapiro SE, Scherer JA, Lasarev MR. Assessing pesticide safety knowledge among Hispanic migrant farmworkers in Oregon. *J Agric Saf Health*. 2004;10:177–186.
7. Quandt SA, Arcury TA, Austin CK, Cabrera LF. Preventing occupational exposure to pesticides: using participatory research with latino farmworkers to develop an intervention. *J Immigr Health*. 2001;3:85–96.
8. Arcury TA, Quandt SA, Dearry A. Farmworker pesticide exposure and community-based participatory research: rationale and practical applications. *Environ Health Perspect*. 2001;109(Suppl 3):429–434.
9. McCauley LA, Beltran M, Phillips J, Lasarev M, Sticker D. The Oregon migrant farmworker community: an evolving model for participatory research. *Environ Health Perspect*. 2001;109(Suppl 3):449–455.
10. Israel BA, Schulz AJ, Parker EA, Becker AB. Community-based participatory research: policy recommendations for promoting a partnership approach in health research. *Educ Health (Abingdon)*. 2001;14:182–197.
11. Anger W, Stupfel J, Ammerman T, Tamulinas A, Bodner T, Rohlman DS. The suitability of computer-based training for workers with limited formal education: a case study from the US agricultural sector. *Int J Train Dev*. 2006;10:269–284.
12. Kamel F, Rowland AS, Park LP, Anger WK, Baird DD, Gladen BC, Moreno T, Stallone L, Sandler DP. Neurobehavioral performance and work experience in Florida farmworkers. *Environ Health Perspect*. 2003;111:1765–1772.
13. Anger WK, Tamulinas A, Uribe A, Ayala C. Computer-based training for immigrant Latinos with limited education. *Hisp J Behav Sci*. 2004;26:373–389.
14. Anger WK, Rohlman DS, Kirkpatrick J, Reed RR, Lundeen CA, Eckerman DA. cTRAIN: A computer-aided training system developed in SuperCard© for teaching skills using behavioral education principles. *Behav Res Methods Instrum Comput*. 2001;33:277–281.
15. Cohen J. *Statistical Power Analysis for the Social Sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
16. Kirkpatrick DL. *Evaluating Training Programs: The Four Levels*. San Francisco: Berrett-Koehler; 1994.
17. Flocks J, Monaghan P, Albrecht S, Bahena A. Florida farmworkers' perceptions and lay knowledge of occupational pesticides. *J Community Health*. 2007;32:181–194.
18. Roman-Muniz IN, Van Metre DC, Garry FB, Reynolds SJ, Wailes WR, Keefe TJ. Training methods and association with worker injury on Colorado dairies: a survey. *J Agromedicine*. 2006;11:19–26.
19. Burke MJ, Sarpy SA, Smith-Crowe K, Chan-Serafin S, Salvador RO, Islam G. Relative effectiveness of worker safety and health training methods. *Am J Public Health*. 2006;96:315–324.
20. Arthur W, Bennett W, Jr., Edens PS, Bell ST. Effectiveness of training in organizations: a meta-analysis of design and evaluation features. *J Appl Psychol*. 2003;88:234–245.
21. Rohlman DS, Gimenes LS, Eckerman DA, Kang SK, Farahat FM, Anger WK. Development of the Behavioral Assessment and Research System (BARS) to detect and characterize neurotoxicity in humans. *Neurotoxicology*. 2003;24:523–531.
22. Strong LL, Thompson B, Koepsell TD, Meischke H. Factors associated with pesticide safety practices in farmworkers. *Am J Ind Med*. 2008;51:69–81.