Assessing Pesticide Safety Knowledge Among Hispanic Migrant Farmworkers in Oregon

L. A. McCauley, S. E. Shapiro, J. A. Scherer, M. R. Lasarev

ABSTRACT. *The purpose of this article is to report on the development and initial use of a pesticide knowledge test (PKT) specifically designed to evaluate agricultural workers' knowledge of the content mandated by the federal Worker Protection Standard (WPS). The PKT is a 20-item, true-false test, used in a sample of 414 adult and adolescent migrant farmworkers in Oregon. The overall mean score, i.e., number correct, was 15.67 (78.4%), with both adults and adolescents demonstrating the most difficulty with questions related to the overall health effects of pesticides. The internal consistency was 0.73, when estimated using a method to correct for small sample sizes. Only six items had less than 70% correct answers. Content validity was achieved by basing the items directly on the Worker Protection Standard; face validity was obtained by having the final version of the test reviewed by a bilingual (English-Spanish) educator familiar with the requirements of the WPS. Overall, adult participants scored better than adolescents, and those with previous pesticide training scored better than those without. There were no differences in scores based on gender or whether the test was taken in English or Spanish; however, participants who spoke indigenous languages scored significantly lower than those who did not. These results indicate that the PKT is a valid, reliable measure of worker knowledge of the content of the WPS, although it does not measure the extent to which that knowledge is actually used in the work setting.*

Keywords. *Agricultural workers, Pesticide knowledge, Pesticide safety.*

The U.S. Environmental Protection Agency (EPA) has established the Worker Protection Standard (WPS) under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) in order to provide guidelines for educating farmworkers about the hazards associated with agricultural chemicals (agrichemicals) (U.S. General Accounting Office, 2000). These rules were originally implemented in 1974 but have been reviewed and revised up through the mid-1990s; the current rules were implemented in 1995 (U.S. General Accounting Office, 2000). The WPS identifies who must be trained, who may do the training, and what must be covered (U.S. Environmental Protection Agency, 2003). Table 1 outlines the major content areas addressed in the WPS.

Under the WPS, all workers who enter an area where agrichemicals have been applied within the past 30 days are required to receive training before beginning their sixth day of work. Workers are required to be trained at least once every five years. The WPS training to which we refer is separate from training specific for pesticide handlers. Pesticide handlers are defined as individuals who mix, load, or apply pesticides, work as

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The authors are **Linda A. McCauley,** PhD, RN, FAAN, Associate Dean for Research, University of Pennsylvania School of Nursing, Philadelphia, Pennsylvania; **Susan E. Shapiro,** PhD, RN, Post-Doctoral Fellow, School of Nursing, **Jennifer A. Scherer,** MPH, Research Associate, School of Nursing, and **Michael R. Lasarev,** MS, Research Associate, Center for Research on Occupational and Environmental Toxicology, Oregon Health and Science University, Portland, Oregon. **Corresponding author:** Linda A. McCauley, University of Pennsylvania School of Nursing, 420 Guardian Drive, Philadelphia, PA 19104-6096; phone: 215-898-3151; fax: 215-898-3056; e-mail: lmccaule@nursing.upenn.edu.

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flaggers, or otherwise are in direct contact with pesticides; pesticide handlers are required to complete additional safety training. The questions developed for use in this study are based on the content given in the mandatory training that is required of all agricultural workers, as opposed to pesticide handlers. Although this standard has been in effect for eight years, little work has been published evaluating the effectiveness of the many training programs currently available (Quandt et al., 1999).

Although substantial numbers of agricultural workers are under 18 years of age (U.S. General Accounting Office, 1998), there are few materials available for teaching pesticide safety targeted to children and adolescents. One such source, Farm Safety 4 Just Kids (FS4JK, 2003), covers general agriculture−related health and safety and is designed to be taught by a parent or 4H group. A second is a comic book, *Aunque Cerca... Sano*, developed jointly by the National Children's Center for Rural and Agricultural Health and Safety (NCCRAHS, 2003) and the Migrant Clinicians Network (MCN, 2003), that focuses primarily on issues related to pesticide safety. Neither of these tools was designed specifically to cover the content in the WPS.

Most training materials for migrant farmworkers are currently available in both English and Spanish. However, the migrant farmworker community is diverse, and increasing numbers of those workers are coming from the southern states of Mexico, where they speak primarily indigenous languages such as Mixteco and Zapoteco. In many cases, these workers have difficulty speaking or comprehending either Spanish or English (McCauley et al., 2002).

The purpose of this article is to report on the development and initial use of a pesticide knowledge test (PKT) specifically designed to evaluate agricultural workers' knowledge of the content mandated by the WPS. We describe the steps used in developing the test and report overall test scores based on several demographic and circumstantial variables including age, gender, recruitment site, and whether the participant is an indigenous language speaker or has ever had the WPS−mandated safety training. We also report on the reliability and validity of the test, based on standard psychometric analyses.

Materials and Methods

Development of the Pesticide Knowledge Test

The pesticide knowledge test (PKT) was designed to test basic pesticide safety knowledge of both English− and Spanish−speaking migrant farmworkers. It was designed as a true/false response test that could be read to Spanish−speaking farmworkers with limited reading skills. The items were designed to cover the required content outlined in the WPS, summarized in table 1. Using the WPS as a guide, questions were formulated to test knowledge related to the health effects of pesticide exposure, pesticide−related safety practices, and general knowledge related to the use of pesticides and possible toxic effects of exposure. Because a significant percentage of agricultural workers are native Spanish speakers, a Spanish version of the PKT was developed using standard techniques of translation and back translation of the original instrument. The initial version, developed in 1998, contained 19 items. It was pilot tested with a small group of Spanish−speaking adolescents (<19 years of age) in an after−school program before being modified and administered with adult (≥19 years old) and adolescent (<19) farmworkers. In 2000, the PKT was revised in order to align it more closely to EPA−prepared training materials. Before being administered to farmworkers, the PKT was reviewed for content and relevancy to the WPS concept areas by three bilingual research assistants familiar with pesticide safety training and one bilingual WPS−certified trainer.

Table 1. Content from WPS required in EPA−mandated training for farmworkers regarding exposures to pesticides (from Ag 857: CFR 40, section 170.130.c.4.i−ii).

1	Where and in what form pesticides may be encountered during work activities.
2	Hazards of pesticides resulting from toxicity and exposure, including acute and chronic effects, delayed effects, and sensitization.
3	Routes through which pesticides can enter the body.
4	Signs and symptoms of common types of pesticide poisoning.
5	Emergency first aid for pesticide injuries or poisonings.
6	How to obtain emergency medical care.
7	Routine emergency decontamination procedures, including emergency eye flushing techniques.
8	Hazards from chemigation and drift.
9	Hazards from pesticide residues on clothing.
10	Warnings about taking pesticides or pesticide containers home.
11	Information regarding actions to reduce the risk of exposure or resulting illness or injury such as application and entry restrictions, warning signs, oral warnings, the availability of specific information about applications, and protection against retaliatory acts.

Source: U.S. Environmental Protection Agency (2003).

Sample

The revised PKT was used in 2001−2002 in a larger study designed to assess the effectiveness of pesticide safety training (McCauley et al., 2002). Using two different strategies, study participants were recruited from agricultural communities in the Willamette Valley of western Oregon during the peak summer harvesting months. First, we recruited a convenience sample of both adolescents (ages 12−18) and adult (19 and older) migrant farmworkers enrolled in a summer evening English as a Second Language (ESL) program in Washington County. Second, we recruited a convenience sample of adolescents and adults residing in migrant farmworker camps in Washington County but who had not enrolled in the summer evening ESL program. For participants from the ESL program, testing took place in the classroom; testing for the remaining participants took place in a common outdoor recreation area in the labor camps. Participants were asked which language version of the test they preferred and whether they preferred to read and answer the questions themselves or to have the questions read to them.

Statistical Methods

Responses to the questionnaires were tabulated and described. The responses involving categorical data were compared using chi−square tests of association. Student's t−test was used to compare knowledge test scores between groups of interest. Multiple regression was used to investigate how the knowledge score was jointly influenced by gender, previous safety training, age, language spoken, and location of recruitment. Statistical analyses were conducted using SPSS (ver. 11.5, SPSS, Inc., Chicago, Ill.) and *R* version 1.7.1 (Ihaka and Gentleman, 1996).

Results and Discussion

The Pesticide Knowledge Test

Table 2 contains the 20 items from the revised PKT, the correct answer for the item, the WPS content area the item was developed to test, and the type of information the item reflected (i.e., health effects, pesticide safety, or general pesticide knowledge). Test

Table 2. PKT items: WPS content areas and test subscales.

Item	Correct Answer	WPS Content Area[a]	Test Subscale[b]
Pesticides are used to kill weeds and insects.	T	1	GK
Pesticides are dangerous to people and animals.	T	2	GK
Some people can get sick from pesticides faster than others even though they work in the same place.	T	2	HE
It is okay to store water in containers that have been used for storing pesticides.	F	10	PS
Sometimes contact with pesticides causes a blister or skin rash.	T	4	HE
With time, pesticides degrade in the environment.	T	11	GK
Pesticide poisonings may have immediate but not delayed effects.	F	2	HE
It is good to apply pesticides on a windy day.	F	8	GK
It is important to read the signs and announcements at the border of the field or orchard before entering.	T	11	PS
It is very easy to identify a sickness triggered by pesticides.	F	4	HE
Eating, drinking, or smoking in the field increases the possibility of pesticides entering the body.	T	3	PS
Pesticides pose few health risks to pregnant women and children.	F	2	HE
Protective clothing should always be worn when mixing or applying pesticides.	T	11	PS
When working in the field, the pesticides can stick to your clothes and shoes.	T	9	PS
Pesticides can enter the body through the skin.	T	3	PS
Soap and water remove pesticides from hands.	T	11	PS
You can eat fruit directly from the tree or plant after it rains because the rain rinses off the pesticide residues.	F	3	PS
If pesticides get on you, immediately remove any contaminated clothing and rinse your skin with water.	T	5	PS
Emergency phone numbers don't have to be posted in common meeting areas.	F	11	GK
It is better to work in shorts, short sleeves, and sandals when it is sunny.	F	3	PS

[a] WPS content areas (see table 1).
[b] GK = general knowledge, PS = pesticide safety, and HE = health effects.

scores were calculated by summing the number of correct answers and reported as either total scores or scores by the area of knowledge tested. The maximum possible score for the PKT is 20; the maximum possible scores for the subscales are: general knowledge = 5, overall health effects = 5, and pesticide safety = 10.

Sample

Four hundred thirty participants were recruited for the study, 428 of them had valid scores on the test. Thirteen participants were excluded from the analysis because either they did not have any experience working in agriculture (n = 11) or they were only participating to pilot the instrument (n = 4); two participants were excluded using both criteria. Table 3 shows the distribution by gender, recruitment site, past pesticide training, version of the test used (English vs. Spanish), and whether the participant indicated

Table 3. Background characteristics of Oregon adolescent and adult farmworker sample, 2001−2002 (*n* = 415).

Characteristic	Adolescents <19 years (*n* = 180)[a]	Adults ≥19 years (*n* = 234)[a]	p value[b]
Gender			
Male	132 (73.2)	178 (76.1)	ns
Recruitment site			
ESL program	60 (33.3)	33(14.1)	<0.001
Indigenous language speaker[c]			
Yes	98 (54.4)	128 (54.7)	ns
Past pesticide training			
Yes	91 (50.6)	151 (64.5)	0.004
Language of test			
Spanish	169 (93.9)	233 (99.6)	0.001

[a] One individual missing data on age.
[b] Chi−squared with one degree of freedom.
[c] One case missing data on indigenous language status.

speaking an indigenous language. Adults were significantly more likely to have been recruited from the labor camps than adolescents ($p < 0.001$) and significantly more likely to have had pesticide training ($p = 0.004$). These results are to be expected, since workers over 21 were not eligible for the ESL program and the older workers had many more opportunities to have received pesticide training than the younger workers. All but 12 participants took the Spanish version of the instrument, and there was no difference in the mean total scores between the two versions.

Test Results

Table 4 shows the means, standard deviations, and median scores for both the total PKT score and the three subscales for the entire sample (N = 415), regardless of gender, recruitment site, age group, past pesticide training, or indigenous language status. The mean total score was 78.4% (SD = 2.32) with the lowest performance in the overall health effects subscale (60.6%, SD = 0.97).

Table 5 shows the results of the univariate comparisons between the groups of interest: males and females, adults and adolescents, indigenous language speaker or not, recruitment site, and whether the respondent had received any pesticide training in the past. As can be seen, adults performed better than adolescent ($p = 0.001$), persons who reported speaking indigenous languages had significantly lower scores than those who did not ($p < 0.001$), and those who reported having received formal pesticide safety training scored significantly higher that those who did not ($p = 0.004$). Results from the multivariable analysis confirmed that those with pesticide training scored significantly higher than those without, and those who spoke indigenous languages scored

Table 4. Pesticide knowledge subscale test scores among migrant farmworkers, 2001−2002 (N = 415).

Scale	Maximum Possible Score	Sample Mean (% correct)	Standard Deviation	Median
General knowledge	5	4.15 (83.0%)	0.83	4
Overall health effects	5	3.03 (60.6%)	0.97	3
Pesticide safety	10	8.49 (84.9%)	1.36	9
Total score	20	15.67 (78.4%)	2.32	16

Table 5. Differences in pesticide knowledge test scores among migrant farmworkers according to gender, age, language spoken, recruitment site, and previous pesticide safety training.

Characteristic	*n*	Mean Number Correct	Standard Deviation	p value
Gender				
Male	311	15.76	2.31	0.190
Female	104	15.41	2.36	
Age group[a]				
Adult	234	16.01	2.25	0.001
Adolescents	180	15.24	2.36	
Indigenous language speaker[b]				
Yes	227	15.24	2.49	<0.001
No	187	16.19	1.99	
Recruitment site				
ESL	93	15.99	2.02	0.136
Labor camp	322	15.58	2.40	
Past pesticide training				
Yes	243	15.95	2.19	0.004
No	172	15.28	2.46	

[a] One individual missing data on age.
[b] One individual missing data on indigenous language status.

significantly lower, regardless of the age group or recruitment site. However, the effect of age group (adolescent vs. adult) was modified significantly by the location of recruitment. Adults from labor camps averaged just over one point higher than teens ($p < 0.001$), and teens recruited from labor camps scored just over one point lower than those recruited from the ESL program ($p = 0.002$). There was no significant difference between adults recruited from ESL vs. the labor camps, and no significant effect attributable to gender.

Reliability and Validity Assessment

When using an instrument such as the PKT, it is important to assess two critical dimensions: its validity and its reliability. Validity refers to the extent to which an instrument evaluates the phenomenon of interest, in this case, the extent to which the PKT is actually measuring knowledge of the material contained in the WPS. Reliability actually refers to two separate concepts. The first is the amount of measurement error reflected in the observed results (referred to as the internal consistency), and the second is the degree to which measurements are repeatable over time. There are many different ways to assess both validity and reliability (Nunnally and Bernstein, 1994).

The Kuder−Richardson−20 (KR−20) is one method of assessing the internal consistency reliability of an instrument with a dichotomous response format (Pedhazur and Schmelkin, 1991), it estimates the proportion of observed variance that can be attributed to the true differences in scores, as opposed to the overall observed differences, which include measurement errors (Nunnally and Bernstein, 1994). Analysis of an earlier version of the PKT suggested that the test contained too few items to yield meaningful results in the KR−20 (McCauley et al., 2002). The short length of the questionnaire was important, however, to keep it “user friendly” in our target population. Fortunately, there is a statistical method for overcoming this problem: the Spearman−Brown prophecy formula, which can be used to estimate the expected increase in reliability when the number of items in a test is increased (Nunnally and Bernstein, 1994). Using this formula, we estimated the KR−20 of a 40−item PKT (twice the current length) to be 0.73.

However, a 40−item test would be too long to administer to migrant farmworkers, so we retained the 20−item test, knowing it suffered a reduction in internal consistency to 0.63 as a result.

Content validity, or the extent to which the questions covered the domain of interest, is a priority in developing tests of mastery (Nunnally and Bernstein, 1994) and in this case was achieved in the initial instrument development by using material directly from the WPS. These were refined in the new version of the test using EPA−developed educational materials designed to teach farmworkers the specific information contained in the WPS. We established face validity, or the degree to which the instrument is recognized on its face as testing the phenomenon of interest, by having the final version reviewed by a bilingual (English/Spanish) WPS trainer who concluded that all items were reflective of required content in the pesticide training standards.

We were also interested in estimating the difficulty of the questions in the PKT. This was done by determining the proportion of participants who answered each question correctly. This ranged from a low of 26.27% who answered item 10 correctly ("It is very easy to identify a sickness triggered by pesticides") to 98.07% who answered item 9 correctly ("It is important to read the signs and announcements at the border of the field or orchard before entering"). Six items had less than 70% correct responses, and these are shown in table 6.

Discussion

In developing the PKT, we purposefully limited the number of test items and kept them simple enough to be given orally to farmworkers who could read neither English nor Spanish. We may have sacrificed the ability to detect subtle differences between the adults and adolescents when we made this choice. We also chose a true/false format for the test questions based on feedback from members of the farmworker community who believed that a multiple−choice format would be more difficult conceptually for workers with limited education. This represented another tradeoff between ease of use of the PKT and the richness of the data that resulted. However, by basing the items directly on the material in the WPS, we have assured the content validity of the PKT. The internal consistency reliability, although difficult to interpret in a test of this length, appears to be adequate for the purpose.

Table 6. PKT items with less than 70% correct answers.

Item	Number Correct (% correct)	Content Area[a]	Subscale[b]
Pesticide poisonings may have immediate but not delayed effects	143 (34.5)	2	HE
It is very easy to identify a sickness triggered by pesticides	109 (26.3)	4	HE
Pesticides pose few health risks to pregnant women and children.	225 (54.2)	2	HE
Pesticides can enter the body through the skin	196 (47.2)	3	PS
You can eat fruit directly from the tree or plant after it rains because the rain rinses off the pesticide residues	279 (67.2)	3	PS
Emergency phone numbers don't have to be posted in common meeting areas	252 (60.7)	11	GK

[a] WPS content area described in table 1.
[b] GK = general knowledge, PS = pesticide safety, and HE = health effects.

Although the actual score differences between adults and adolescents were small, adults in our sample performed significantly better than the adolescents, and those with previous pesticide training performed significantly better than those without. The interaction effects between age and recruitment location most probably reflect the fact that the ESL program only accepts students up to the age of 21. The adults recruited from the ESL location ranged in age from 19 to 21, making them more similar to the adolescents than the older adults in the sample from the labor camps.

The results we are reporting are logically consistent; one would expect that older workers with more experience and those acknowledging past training would score higher than their comparison groups. It is also reasonable that those who indicated they spoke indigenous languages would score significantly lower than others. These farmworkers often understood no English at all, and spoke only limited Spanish. Assessment of the level of comprehension for these workers is difficult at best, and there is a real scarcity of outreach workers to assist research teams with this assessment. Because of this, we could not separate these problems from assessing the actual level of knowledge of the learner, or problems with how the questions were written. This indicates that with the increase in numbers of migrant farmworkers in the U.S. who speak indigenous languages (or any languages other than English or Spanish), the challenges of developing language− and culture−appropriate learning materials and knowledge tests will need to be addressed more formally.

Again, the differences in scores between participants who reported receiving pesticide safety training compared to those who reported having never received training were small, although statistically significant. Because we focused on simple questions that could be answered true or false, and because the questionnaire was short, it appears that the instrument lacks the capability to differentiate knowledge of more complex aspects of the work safety environment. In addition, the test does not assess the worker's ability to integrate pesticide safety knowledge into problem−solving situations that might be better tested with multiple−choice or open−ended questions.

The six most difficult questions on the PKT (table 6) include items in all three knowledge areas (pesticide safety, health effects, and general pesticide knowledge). There was no indication in the pilot work that these questions were any more difficult or less well−worded than others on the instrument. Nonetheless, this instrument is new, and it is not yet clear whether these scores represent a problem with the question or a lack of knowledge on the part of the participants. As table 4 indicates, the sample as a whole scored lowest (60.6% correct) on the questions having to do with health effects of pesticides. This may be related to the different ways in which workers obtain information about pesticides and about health and illness (Salazar et al., 2004). In focus groups that we have conducted with adolescent farmworkers (Salazar et al., 2004), adolescents indicated that parents, family, and friends, rather than mandated training programs, were their major sources of pesticide−related information. Inaccurate beliefs related to health effects may thus be passed from one generation to the next. Additionally, migrant workers bring culturally specific health beliefs from their countries of origin. For example, studies report a perceived resiliency to pesticide exposure among certain Mexican populations that is not related to the actual health effects of these same chemicals (Hunt et al., 1999; Lantz et al., 1994; Salazar et al., 2001). Lastly, delayed health effects of pesticide exposure may not be seen or experienced until years later, and may not be attributed to pesticides or farm work.

As has been mentioned, although we found statistically significant differences between adults and adolescents in some areas, the actual point differences in the PKT were small. This is probably due to the short length of the questionnaire; had there been more questions, it is likely that the mean difference in total PKT scores between adults and adolescents would be greater. The practical meaning of this difference is difficult to interpret further since this is the first time the test has been used.

These results are subject to several limitations. First, the participants were self−selected and do not represent a cross−section of all migrant farmworkers, whether adolescent or adult. Second, there are no data on WPS−based pesticide knowledge among non−migrant agricultural workers against which to compare these results. It is also important to remember that the PKT evaluates only the ability to respond to verbal questions about the training materials, which may or may not translate into desired work−place safety behaviors.

Finally, the PKT is a new instrument, designed to test the extent to which migrant farmworkers have mastered the content of the WPS, and because it is so new, the results of the reliability and validity assessments are applicable only to this sample. Although we are confident that the PKT has given us a reliable estimate of the degree to which our sample knows the content of the WPS, and we fully intend to use it in the future with other studies involving migrant farmworkers' knowledge of pesticide−related safety issues, its reliability and validity need to be re−evaluated with each new sample in each new setting.

Conclusions

There is a paucity of information related to characteristics of the adolescent migrant farmworker community, and as has been reported, this may be a population that is especially vulnerable to the adverse health effects of pesticide exposure (Committee on the Health and Safety Implications of Child Labor, 1998; Golub, 2000; Quandt et al., 1999). The findings in this report suggest that adolescent knowledge of pesticide safety, measured with a simple, culturally appropriate instrument, appears to approximate that found among adult farmworkers. However, both adults and adolescents could benefit from an increased knowledge of the health effects associated with pesticide exposure. It must be emphasized that assessment of knowledge does not always equate with actual work practices. Studies are needed that examine the correlation of knowledge scores with observed work behaviors. The language and cultural background of the migrant labor workforce create challenges in the delivery of effective job safety education. Studies are still needed to identify the most effective teaching interventions with this highly diverse group of workers.

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