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Oregon Indigenous Farmworkers: Results of *Promotor* Intervention on Pesticide Knowledge and Organophosphate Metabolite Levels

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Abstract

Objectives—Examine changes in health beliefs, pesticide safety knowledge, and biomarkers of pesticide exposure in indigenous farmworker who received enhanced pesticide safety training compared to those receiving the standard training.

Methods—Farmworkers in Oregon were randomly assigned to either a *promotores* pesticide safety training program or a standard video-based training. Spot urine samples were analyzed for dialkylphosphate (DAP) urinary metabolites. Pre/post intervention questionnaires were used to measure pesticide safety knowledge, health beliefs and work practices.

Results—Baseline to follow-up improvements in total pesticide knowledge scores were higher in the *promotor* group compared to the video. Pairwise differences in mean concentrations of DAP metabolite levels showed declines from baseline to follow-up for both intervention groups.

Conclusions—Results showed reductions in pesticide exposure in indigenous-language speaking farmworkers who receive enhanced pesticide safety training.

Introduction

The agricultural industry in the United States is highly dependent on immigrant populations for its crop production with the National Agricultural Workers Survey (NAWS) estimating that 78% of farmworkers in the United States are immigrants ¹. Furthermore, indigenous farmworkers – farmworkers from Mesoamerican communities that are mostly self-governing and speak an indigenous language as their primary language -- often work in the most labor-intensive crops in the U.S. The past two decades have resulted in increasing

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numbers of migrants arriving in the United States from indigenous communities in Mexico and Guatemala and speaking indigenous languages such as Mixteco, Zapotec and Triqui ²⁻⁸.

Typically, Latino workers whose native language is an indigenous language speak only rudimentary Spanish, and have distinct cultural traditions ^{3-5,9}. There is no current uniform written format for many indigenous languages and many indigenous workers were unable to attend school past the fourth or fifth grade which makes it difficult for social service providers and others to communicate with or provide services to many indigenous farmworkers and for indigenous farmworkers to communicate to their employers and co-workers.

Few federal standards protect agricultural workers' occupational health and safety. Pesticide safety is a major concern and agricultural workers can be exposed to pesticide spray, drift, and residues in the soil and on foliage ¹⁰⁻¹². The Environmental Protection Agency (EPA) Worker Protection Standard, implemented in 1996, is designed to ensure that all agricultural workers receive basic training in pesticide safety within the first five days of entering a treated area. Most frequently the training is conducted in either English or Spanish. There are no state- or federal-specified guidelines on how to provide culturally and linguistically appropriate training of the increasing numbers of farmworkers whose primary language is indigenous, who speak neither English nor Spanish, or who understand very rudimentary Spanish at best. Little is known about the effectiveness of the Worker Protection Standard (WPS) training program, particularly if the training is provided in a language the worker does not fully understand, or if the training is delivered in a culturally inappropriate manner.

In this paper we describe the characteristics and outcomes related to a community-based participatory research project aimed to deliver culturally and linguistically appropriate pesticide training to farmworkers who speak indigenous languages. We hypothesized that indigenous-language speaking farmworkers who receive enhanced pesticide safety training from peer educators and through indigenous-language educational materials will experience less pesticide exposure than comparable indigenous-language speaking workers who receive only the standard training required under the WPS in Spanish. We examined the associations between this innovative training intervention and indigenous farmworkers participants' health beliefs, pesticide knowledge and biomarkers of pesticide exposure.

Methods

Setting

The research took place during the summers of 2010 and 2011 in the Willamette Valley region in Oregon as part of a community-based participatory research program among the indigenous farmworker community, farmworker advocacy organizations, and university researchers. Grounded in participatory methodology, significant preliminary work in the areas of outreach to indigenous communities, education and training, focus groups, and farmworker surveys laid the foundation for the current intervention ^{4,5,13}. In our previous work we further identified the communities in which individuals speaking indigenous languages lived and worked to train and develop the skills of three community outreach educators who spoke the predominant languages and whose role was centered on gaining and maintaining the communities' trust in this study.

We conducted formative research that revealed farmworkers feel disrespected, discriminated against, and disregarded at the workplace ³. While Spanish-speaking farmworkers face similar occupational difficulties, it became clear through the focus groups that indigenous-language speaking workers face even greater obstacles, due to linguistic and cultural differences. General information, such as that provided by health educators or included in

radio broadcasts, was mentioned as being inaccessible, because it is rarely provided in indigenous languages. The second recurring theme that surfaced in the analysis of the focus groups was the exposure to numerous occupational hazards and a general lack of safety measures provided to indigenous farmworkers. In part because of the cultural and linguistic differences, indigenous farmworkers needs are often overlooked in the workplace and the workers described how they felt undervalued, and overlooked and ridiculed.

The project focused on workers employed in nursery and vineyard operations in the Willamette Valley area of Oregon. Oregon's nursery and greenhouse production ranks behind only California and Florida¹⁴ and leads all states in growing area and sales of shade trees, coniferous evergreens, flowering trees, and Christmas trees. Oregon is second in its sale revenue of broadleaf evergreens such as azaleas, fruit and nut plants and ranks third in shrubs and propagation material. Oregon nurseries and greenhouses are second in both numbers of operation and hired workers in the nation. Approximately 80% of Oregon's nursery and greenhouses are in the Willamette Valley¹⁴.

Recruitment

We recruited individuals between the ages of 18 to 55 and who spoke an indigenous language as their primary language. To be eligible to participate in the study, individuals had to have worked in an Oregon nursery or vineyard for at least six months prior to entry into the study and be currently employed for at least 30 hours of work per week in a nursery operation in the previous 30 days. Potential participants were excluded from the study if they reported that they have ever had an acute pesticide poisoning or any chronic disease such as diabetes, HIV, or hepatitis.

Recruitment was conducted by indigenous language-speaking community educators to nursery workers residing in the northern Willamette Valley in Oregon. Recruitment efforts took place where indigenous language speaking nursery workers lived or were likely to congregate but not at the work site. In the consent process we explained that we were studying exposures to pesticides in farmworkers and trying to determine the most effective way to train workers about pesticide safety. Potential participants were also told that we are studying the degree to which they are exposed to pesticides and the potential effects of such exposures on the cells of their bodies. The procedures for obtaining urine samples were explained. All procedures were reviewed and approved by the Emory University IRB.

Intervention

Prior to recruitment of workers, randomization of the intervention was done by pre-assigning geographic locations of nurseries and vineyards where study participants might be employed to either the training intervention delivered by indigenous-language speaking *promotores*, or the control intervention consisting of a Spanish WPS video training. The *promotor* or peer educator training curriculum was developed based on our previous community engagement^{3-5,13}.

The major topic areas of the curriculum were pesticides and health including routes of exposure, labels, reducing pesticide exposure at work, what to do if exposed to pesticides, the WPS requirements, understanding rights at the workplace, and overcoming barriers to reporting exposure. The training portion of curriculum was no more than 60 minutes including questions. The curriculum also included a low literacy crop booklet containing information in a pictorial format on the short- and long- term health effects of the pesticides used in the nursery industry in Oregon. Participants were also given CDs containing *sociodramas* that explained, in a story format the risks of pesticide exposure. Participants in the intervention group were also contacted by the peer educators within two weeks of the

group training and individual questions were answered or supplementary explanations were given.

Participants in our control group were shown an EPA video in Spanish that is routinely used in agricultural industry and given an opportunity to ask questions. They also received a standard EPA brochure in Spanish summarizing the major points of the video. While this control group intervention consisted basically of what is required by law, in our previous investigations we have found that depending on the type of crop and location only between 30-70% of farmworkers in Oregon report receiving this required training ^{4,5}.

Both the *promotor* intervention and the control intervention took place in community buildings in evening hours after work and were delivered in a participatory manner, in small group sessions. Participants were invited for follow-up testing 6 weeks after the baseline assessment for both survey years. Baseline testing for 2010 took place in March through April and in April through May for survey year 2011. Follow-up testing occurred April to May and May to June of 2010 and 2011, respectively.

Instrumentation: Pesticide Safety Knowledge, Beliefs, and Practices

Three pre/post intervention questionnaires used by the authors in previous studies of this type were used to measure knowledge, beliefs and practices regarding pesticide safety. The work practices instruments contained items on type of work activity, pesticides used, crop or commodity, hours per week, use of protective clothing, hand washing at work, bathing, laundry, and clothing worn both inside and outside of work ^{3,13,15-17}. The *Pesticide Knowledge Test* was used to assess participants' grasp of basic pesticide safety information required in the WPS training for farmworkers. The questionnaire consisted of 20 true-false items and measured knowledge in three topical areas: (1) general knowledge related to use of pesticides (n= 2 questions); (2) pesticide safety (n= 7 questions); and (3) worker rights and protection (n= 11 questions) ^{2,18}. The *Farmworker Health Beliefs* tool contains 6 items to determine judgment of perceived harm from pesticide exposure ².

Biomarkers of Pesticide Exposure

The next step of the intervention consisted of taking urine samples to assess actual exposure to organophosphate pesticides, a class of pesticides widely used in agriculture. Single void (spot) urine samples were collected from the study participants at pre- and post-testing sessions. All samples were collected at approximately the same time of day (6-8 PM) and transported on ice to the lab facility where they were stored at -80°C in tubes without any additives. Samples were analyzed for the following five dialkylphosphate (DAP) metabolites of organophosphate metabolites: dimethylphosphate (DMP), dimethylthiophosphate (DMTP), dimethyl-dithiophosphate (DMDTP), diethylphosphosphate (DEP), and diethylthiophosphate (DETP). Aliquots of the samples underwent azeotropic distillation, centrifugation, and evaporation under a nitrogen stream, with reconstitution in acetonitrile and derivitization with pentafluorobenzylbromide and heating to convert phosphate acids to esters. The metabolites were analyzed by gas chromatography with pulse flame photometric detector (GC-PFPD) as previously described by Lambert *et al.*¹⁹ and confirmed with gas chromatography/ mass spectrometry (GC-MS). The method has good precision, excellent recovery and detection limits of µg/g ^{17,20}. All urine samples were measured for creatinine concentration (mg%) using a Sigma diagnostic creatinine assay kit and a Spectramax 190 Spectrophotometer to identify abnormal samples.

Statistical Analysis

Work and Hygiene Practices—Descriptive statistics were used to compare demographic and work characteristics of intervention and control participants. An overall

hygiene-index score (range 0-12) was computed by summing responses to four items from the questionnaire: (1) removing work boots prior to entering the home, (2) time interval before changing work clothes, (3) time interval before showering after work, and (4) washing hands before eating at work. The difference in hygiene-index scores was computed between baseline and post-training assessments for control and intervention groups. Paired t-tests were used to compare baseline to follow-up differences in hygiene index scores within groups and independent t-tests were used to compare differences between groups at baseline or at follow-up testing.

Pesticide Knowledge Test—The difference in the number of correctly answered items out of 20 on the pesticide knowledge test was computed for each participant at pre- and at post-assessments. To assess whether an intervention had an impact on PKT scores, an appropriate mean PKT score difference variable (PKT score at follow-up minus PKT score at baseline) was constructed and compared using one-way analysis of variance (ANOVA). If the overall F test was significant, post hoc comparisons were performed using the conservative Tukey procedure to evaluate pairwise differences. For analysis of change in means knowledge scores, we used a multiple regression technique with mean PKT score difference as the dependent variable. Average baseline to follow-up differences were compared for the two intervention groups using a multiple regression model, with treatment (intervention vs control) regarded as a main factor of interest.

Organophosphate Metabolites—Standardization of the DAP metabolites was performed by adjusting all metabolites for creatinine and was expressed in ug/g of creatinine. For statistical purposes, non-detectable levels of each metabolite were replaced by one-half the square root of the Limit of Detection (LOD) for the measurement in question. The molar equivalent concentration of the DAPs was summed to create a summary DAP measure. Raw data was summarized using the median and inner-quartile range and log-transformed (to improve symmetry and mute the effect of outliers) prior to further analysis. Paired t-tests were applied to examine differences between (log-transformed) baseline and post-training metabolite levels within participants and communities over time. All analyses were performed using SAS version 9.3²¹.

Results

In 2010 and 2011, we recruited a total of 164 nursery/vineyard workers in our study and randomly assigned each participant to one of the following intervention groups: (1) *Promotor* training and (2) EPA's Worker Protection Standard (WPS) video. We restricted our analysis to the 138 participants who completed pre- and post-Pesticide Knowledge Tests (PKT) and provided biosamples, resulting in 83 farmworkers in the *promotor* and 57 in the video group with average ages of 37.2 ± 9.3 and 35.6 ± 8.5 respectively. The sample consisted of 85 males and 53 females, two participants were missing gender identification. We were able to retain 84% of our subjects for the follow-up testing. Workers who did not return for the follow-up testing did not differ from those who did by gender, treatment group, age, or U.S. education. We chose to analyze these two study years combined to provide a substantial gain in power and therefore increase our ability to detect a moderate to small intervention effect size. Given that follow-up and baseline assessments did not occur in the same months of 2010 and 2011, the potential for a seasonal bias in the detection of organophosphate metabolites in this analysis was likely. Therefore, we examined seasonal variability across survey years and observed no difference in mean summary organophosphate levels across collection date (GLM $p=.5$).

Table 1 presents the demographic characteristics of nursery workers in the *promotor* and video intervention groups. At baseline there were no significant differences between the two

groups with the exception of group differences in total hours worked per day. The *promotor* group reported working fewer hours per day (average of 8.2 hours $\pm$ 0.74) compared to the video group (average of 8.6 hours $\pm$ 0.7) (pooled $t=2.62$, $p=.01$). Total hours worked per day did not change significantly from baseline to the follow-up testing (overall 8.4 hours at baseline to 8.3 hours at follow-up; [$t=0.96$, $p=.34$]).

Job Activities

Job activities were similar in both males and females with the large majority engaged in pruning, weeding and planting. Participants were also asked if they worked in a greenhouse. Women were more likely to report having worked in a greenhouse (56.6% (N=30) of women compared to 34.1% (N=29) of men; [$X^2=6.74$, $p<.01$]).

Prior Pesticide Training

Participants were asked at baseline if they had previously received pesticide training. Approximately 34% of participants in our study reported having received previous pesticide training; 30 (36%) and 18 (34%) in the *promotor* and video groups, respectively. There were no significant differences between groups in terms of receipt of previous pesticide training observed at baseline or follow-up.

Mixing/Applying Pesticides

The participants who reported they applied or mixed pesticides at work were equally distributed representing a total of 13 (22.8%) participants in the video and 14 (16.9%) *promotor* intervention groups. Workers who reported they applied or mixed pesticides at work were no more likely to report having received pesticide safety training than those who did not report handling pesticides.

Outcome of Training Intervention on Knowledge Scores

A total of 138 subjects completed both the pre and post pesticide knowledge tests. The instrument was moderately reliable. The estimated Cronbach's Alpha () for all 20 items was approximately .62 for both tests. The average item difficulty ranged from .79 and .81 in the pre- and post-test, respectively. This value is close to the optimal item difficulty for dichotomous items (.75). No items warranted deletion due to poor item functioning. Reliability estimates for the subscales were as follows: (pesticide safety scale)=.45, (worker protection)=.62 and (General Knowledge)=.24. Low or marginal reliabilities in the subscales are likely a function of scale length. The psychometric characteristics were comparable to that observed in previous studies using this instrument¹⁸.

Table 2 contains the mean scores for total pesticide knowledge and related subscales for the *promotor* and video intervention groups at baseline and follow-up testing. The mean total knowledge scores at baseline for both groups combined was 15.76 ± 2.52 , which ranged from a total of 2 to 20 correct responses, reflect above average pesticide knowledge. Knowledge scores for the targeted subtopics were equally as high. While both groups showed significant improvements in pesticide knowledge at post-testing, baseline to follow-up improvements in total pesticide knowledge scores were higher in the *promotor* group compared to the video intervention (mean score difference= 2.31 ± 2.25 versus 2.17 ± 2.31 respectively; [$F=4.405$, $p=.01$]). No significant differences were found between the participants in the *promotor* and video interventions when examining the individual mean knowledge subscale scores with one exception. Although mean pesticide safety scores improved for both groups, improvements in mean change from baseline scores were higher for the video intervention

compared to the *promotor* group (0.3214 ± 1.47 compared to $.0732 \pm 1.15$ respectively; $[F=4.951, p<.01]$).

The *promotor* group showed significant pair-wise changes in total knowledge scores with an average gain of 2.3 points ($SD=2.3$) at post-test ($t=9.31, p<.0001$). Participants in the *promotor* training also showed baseline to follow-up improvement in understanding general pesticide safety and worker protection and rights issues, though these differences were of borderline significance. We also observed significant pairwise changes in mean total pesticide knowledge scores for participants in the control group, whose scores improved an average of 2.17 points ($SD=2.1$) at follow-up ($t=7.04, p<.0001$). For both the *promotor* and video interventions, within group improvement in scores did not differ by age, gender, year of participation, or previous pesticide training.

Changes in knowledge scores were not correlated with age, years in the US, or hours worked in agriculture per day; whereas improvement in knowledge scores was positively correlated with years working in a nursery for the *promotor* intervention ($\rho=0.165, p=.05$). The numbers of subjects mixing/applying pesticides were small, but the change in knowledge scores was not influenced by mixing/applying pesticide status.

Outcome of training on work practices

An overall hygiene-index score (range 0-12) was computed by summing responses to four items from the Work Practices questionnaire: (1) removing work boots prior to entering the home (sometimes, always, never); (2) time interval before changing work clothes (immediately, within 30 minutes, > 30 minutes); (3) time interval before showing after work (immediately, within 30 minutes, > 30 minutes); and (4) washing hands before eating at work (sometimes, always, never). Baseline hygiene index scores in both groups ranged from 7 to 12. Participants in the video group reported a median hygiene index score of 11 (mean=10.57), while the *promotor* group reported a median score of 10 (mean=10.28). The WPS video control group showed a statistically significant increase in mean hygiene scores from baseline to follow-up (post= 11.04 ± 1.13 vs. pre= 10.57 ± 1.35 ; $p< 0.01$). We did not observe a statistically significant difference in hygiene score improvement between the video (post-score= 11.04 ± 1.13) and *promotor* (post-score= 10.37 ± 1.62) intervention groups at follow-up ($p=0.12$). Gains in hygiene scores were not related to gender, study year, previous pesticide safety training, age, years working in the US, or daily hours worked in agriculture. Years working in nurseries was significantly associated with hygiene index improvement among participants in the *promotor* group ($\rho=0.30$; $p=0.02$). However, this association was not observed for the video group.

Outcome of Training Intervention on Metabolite Levels

A total of 138 provided pre and post specimens for urinary metabolite analyses. At baseline, DMP and DMTP were the most frequently detected metabolites (84.8% and 66.7% of all samples, respectively); though slightly lower this trend persisted at follow-up (42.0% and 64.5% of all samples, respectively). Detectable levels of DEP at baseline and follow-up were found less frequently (7.3% and 8.0% respectively).

Creatinine-adjusted microgram per gram equivalents for each of the 5 metabolites were summed to create a summary DAP metabolite measure. At baseline, the total metabolite levels ($\mu\text{g/g}$ Creatinine) for these 5 metabolites ranged from 9.48 to 977.24 with an average of 77.26 (SD 2.37) and a median of 70.53. At follow-up, the total metabolite levels ($\mu\text{g/g}$ Creatinine) for these 5 metabolites, ranged from 11.31 to 446.89 with an average of 40.64 (SD 2.47) and a median of 36.92.

The geometric mean (GM) concentration of OP metabolites and 95% confidence intervals stratified by time point and intervention group are given in Table 3. No significant differences were noted in metabolite concentrations at baseline between the two intervention groups, except for differences in the DMDTP metabolite. Mean DMDTP metabolite levels were higher in the video group compared to participants in the *promotor* training (7.02 µg/g Cr versus 3.97 µg/g Cr respectively, $p < .01$). While pairwise differences in mean concentrations of DMP, DMDTP, DETP, and summary DAP metabolite levels showed declines from baseline to follow-up for both intervention groups; the *promotor* group showed significantly greater reductions in mean DMP and DMDTP levels (−3.72 µg/g Cr and −2.61 µg/g Cr respectively) compared to the video intervention (−2.38 µg/g Cr and −1.3 µg/g Cr respectively). Reduction in metabolite levels was not associated with years worked in a nursery, nor whether subjects reported mixing/applying pesticides at work, work activities (pruning, weeding, planting), prior pesticide training, monthly or seasonal variations in pesticide levels across the two years of data collection, or whether they were offered protective equipment by their employer.

Discussion

Though the Worker Protection Standard was implemented in 1996, 5 studies have consistently reported that farmworkers do not receive the training mandated by the law and that their levels of understanding of pesticide safety and regulation are less than optimal²²⁻²⁸. Results of this study showed reductions in pesticide exposure in indigenous language speaking farmworkers who receive enhanced pesticide safety training from peer educators and educational materials in Spanish or in their indigenous language compared to indigenous language speaking workers who receive only the minimum training required under the Worker Protection Standard (WPS).

We have used our pesticide knowledge test for more than a decade to measure knowledge among Spanish-speaking farmworkers^{16,29}. This is the first time that we have used the instrument with farmworkers employed in the nursery industry. In our previous work we observed that young farmworkers who spoke indigenous languages had knowledge scores approximately 7 points lower than those who spoke Spanish as their primary language²⁹. In this sample of older workers in nursery operations, their baseline knowledge scores were similar to those previously found among Spanish-speaking farmworkers harvesting crops 16.2 ± 2 and higher than that observed in crop workers speaking indigenous languages (15.2 ± 2)¹⁸.

We observed that while only 30 % of the participants in the study reported they had received prior pesticide training, overall the baseline scores were high. In developing the knowledge test, we purposefully limited the number of test items and kept them simple enough to administer orally to farmworkers. Doing this may have limited our ability to detect subtle differences between intervention groups. Only 6 items had less than 70% correct answers at baseline. These relatively high knowledge scores created a “ceiling” effect, potentially limiting our ability to observe greater improvement in actual scores. However, a mean improvement in 2 points in a raw score of 20 reflects a 10% improvement in overall knowledge in both groups. The self-reported previous pesticide training is disturbing in a group of farmworkers who have worked in nursery operations for more than 8 years. This was particularly true when in addition some of the workers reported that they were not only planting, weeding or other field activities but mixing and applying pesticides as well.

We found that both interventions resulted in improved hygiene scores on items that have been reported as influencing the amount of pesticide residue to which workers are exposed.

A limitation of this study is our inability to do observations on behavior to validate reported activities.

While the results of this study are especially innovative in that we were able to go beyond traditional exposure assessment approaches that solely rely on self-report measures to: (1) link work practice to actual exposure levels; (2) contrast health beliefs to actual exposure; and (3) combine biologic and self-report exposure data, a significant limitation was that OP exposure was collected at one time point before and one time point after the intervention. Arcury et al.³⁰ have demonstrated that seasonal variation in OP pesticide levels is a key predictor that should be included in exposure assessment studies. Future studies employing a repeated measures design are warranted to more accurately reflect pesticide exposure for farmworkers across the growing season. The addition of biomarkers of effect, including DNA damage or DNA adducts, may prove useful by delineating the intermediate biologic mechanisms that link biomarkers of exposure to known human health effects. To our knowledge, this is the first study to document a reduction in urinary pesticide metabolites after an educational intervention. While we had hypothesized that study participants who received a *promotor* intervention would have the greater reduction in overall metabolites, we found that both interventions resulted in a reduction in metabolite levels over baseline levels. While the EPA video is frequently used in agricultural settings and is in Spanish, we administered the video in small group settings, in a quiet environment, and provided participants with an opportunity to ask questions after watching the video from an indigenous-language speaking peer educator. This is quite different than many work settings where the video is shown to all workers in a large common area without a real opportunity to discuss the training material and raise questions. This points to a well-accepted educational principle that it is not only the content of an educational program, but the method of delivery that impacts the effectiveness of the intervention. Future studies should focus not only on the method of education, but the settings in which it is employed. Unfortunately the WPS does not have any requirements regarding the method of training that the worker has to receive, only that the training be given every 5 years.

Conclusions

One advantage to the training format was that the workers were able to congregate in small groups where other co-workers were also indigenous and they could ask questions after the film may have been helpful in improving the scores for the control group. The fact that both field workers and those who are self-reporting as having mixed or applied are receiving no more than 30 percent training participation in the work setting is alarming. It is alarming that low percentages of both field workers and those who report as having mixed or applied pesticides have received prior pesticide training. At the same time, it appears that most workers surveyed, perhaps due to the length of time working in nurseries, have conceptually understood some safety measures. Even though many of the workers with prior training entered this study with relatively high knowledge scores, those scores did not have a direct relationship with lower metabolite levels associated with OPs. In other words, higher scores did not guarantee lower exposure. Future studies should not only test in more frequent intervals, but should allow a setting in which the employer is providing the basic requirements for compliance with recommended protective practices, i.e. sinks for washing hands, and the workers' compliance with the recommended protective practices are observed.

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Table 1

Demographic characteristics of participants in Promotor (N=83) and Video (N=57) intervention groups (N=140).

Characteristic	Promotor n (%) / mean $\pm$ SD	Video n (%) / mean $\pm$ SD	P-value*
<i>Female</i>	35 (42.2)	18 (31.6)	0.20
<i>Age(in years)</i>	37.2 $\pm$ 9.3	35.6 $\pm$ 8.5	0.29
<i>Hours Worked Per Day</i>	8.6 $\pm$ 1.1	8.2 $\pm$ 0.7	0.01
<i>Years worked in a Nursery</i>	8.4 $\pm$ 5.1	9.0 $\pm$ 7.3	0.65
<i>Years of Foreign Education</i>	4.8 $\pm$ 3.3	5.4 $\pm$ 3.2	0.26
<i>Speak Only Indigenous</i>	12 (13.4)	11 (19.3)	0.35
<i>Language^a</i>			
<i>Applied Pesticides at Work</i>	14 (16.9)	13 (22.8)	0.38
<i>Other agricultural work?</i>	14 (17.1)	9 (15.8)	0.84
<i>Smoked in the two weeks prior to study?</i>	7 (8.4)	5 (8.8)	1.00
<i>Drank alcohol in the two weeks prior to the study?</i>	16 (19.3)	13 (22.8)	0.61
<i>Reported prior pesticide training</i>	30 (36.1)	18 (31.6)	0.58
<i>Antioxidant Score</i>			
<i>Baseline</i>	16.8 $\pm$ 5.4	16.5 $\pm$ 5.3	0.70
<i>Follow-up</i>	15.9 $\pm$ 4.1	16.5 $\pm$ 5.3	0.46

^a“Speak Only Indigenous Language” captures those who did not report speaking a language besides their native, indigenous language.

* Between group comparisons

Table 2

Total Pesticide Knowledge test and subscales mean scores for participants in the promotor and video intervention groups, Oregon 2010 and 2011.

Knowledge Scores	Max score	<i>Promotor</i> Intervention (n=82)			P ^a	Video Intervention (n=56)			P ^a
		Baseline mean ± SD	Follow-up mean ± SD	MCB mean ± SD		Baseline mean ± SD	Follow-up mean ± SD	MCB mean ± SD	
<i>Total</i> [±]	20	13.50 ± 1.8	15.82 ± 2.0	2.32 ± 2.3 ^{*,**}	<.0001	12.86 ± 2.6	15.04 ± 2.4	2.17 ± 2.3 [*]	<.0001
<i>Subscales</i>									
<i>PS</i> [±]	7	6.45 ± 1.0	6.52 ± 1.1	0.07 ± 1.2	.57	6.02 ± 1.5	6.34 ± 1.3	0.32 ± 1.5 ^{**}	.11
<i>GK</i>	2	1.45 ± 0.7	1.60 ± 0.6	0.15 ± 0.7	.05	1.16 ± 0.8	1.23 ± 0.7	0.07 ± 0.6	.39
<i>WP/R</i>	11	7.74 ± 0.9	8.00 ± 0.8	0.23 ± 1.2	.08	7.59 ± 1.5	7.89 ± 0.9	0.30 ± 1.5	.13

M=Mean, SD=standard deviation. Total= Sum score of correct responses for all Pesticide Knowledge questions. PS= Pesticide Safety. GK= General Knowledge.

WP/R= Worker Protection and Rights. HE= Health Education. MCB= Mean change from baseline to follow-up testing (*post-sum score- pre-score* sum=MCB).

* p <.0001 (P value for pairwise differences in mean knowledge scores).

** p <.01 (Comparisons of between group differences in mean score change from baseline to follow-up using ANOVA).

Table 3

Urinary DAP metabolite levels at baseline and follow-up.

OP Metabolite	Group	Time	% Detected	Creatinine-adjusted ($\mu\text{g/g}$)		
				GM	(95% CI)	P-value ^a
<i>DMP</i> ##	<i>Promotor</i> *	Pre-	83	29.16	(22.28, 38.15)	.05
		Post-	37	7.83	(6.06, 10.11)	
	Video **	Pre-	88	29.39	(21.78, 39.65)	
		Post-	50	12.36	(8.20, 18.61)	
<i>DEP</i>	<i>Promotor</i>	Pre-	5	2.32	(2.08, 2.60)	.25
		Post-	4	2.24	(2.09, 2.40)	
	Video	Pre-	11	2.62	(2.15, 3.18)	
		Post-	14	2.82	(2.30, 3.47)	
<i>DMTP</i>	<i>Promotor</i>	Pre-	66	10.39	(7.59, 14.24)	.64
		Post-	61	9.98	(7.50, 13.28)	
	Video	Pre-	68	7.45	(5.50, 10.07)	
		Post-	67	7.93	(5.62, 11.19)	
<i>DMDTP</i> †	<i>Promotor</i> #	Pre-	41	3.97	(3.14, 5.02)	<.001
		Post-	20	2.72	(2.19, 3.38)	
	Video *	Pre-	63	7.08	(4.81, 10.43)	
		Post-	25	2.58	(2.14, 3.12)	
<i>DETP</i>	<i>Promotor</i> #	Pre-	45	6.07	(4.52, 8.14)	.27
		Post-	55	3.59	(2.93, 4.41)	
	Video	Pre-	36	5.39	(3.68, 7.90)	
		Post-	48	3.53	(2.62, 4.77)	
<i>Summary DAP</i>	<i>Promotor</i> *	Pre-	95	77.48	(63.92, 93.91)	.57
		Post-	81	37.97	(32.02, 45.04)	
	Video #	Pre-	98	76.95	(61.25, 96.67)	
		Post-	82	44.91	(33.75, 59.77)	

Promotor intervention (N=82); Video intervention (N=56). GM=geometric mean, CI= confidence interval.

DMP= dimethylphosphate, DMTP=dimethylthiophosphate, DMDTP= dimethyl-dithiophosphate, DETP= diethyl-thiophosphate, DEP= and Summary DAP= summary measure of 5 individual OP metabolites.

* Pairwise differences significant at $p<.0001$.

** Pairwise difference significant at $p<.001$.

Pairwise difference significant at $p<.01$.

^a Anova: Test difference in Mean PKT Score Change from Baseline after adjusting for baseline metabolite levels.

Mean reduction in metabolite levels from baseline are higher in *promotor* group $p<.05$.

† Mean reduction in metabolite levels from baseline are higher in *promotor* group $p<.001$.