Attending to Pesticide Exposure and Heat Illness Among Farmworkers

Results From an Attention Placebo-Controlled Evaluation Design

Joseph G. Grzywacz, PhD, Melinda Gonzales-Backen, PhD, Amy Liebman, MPH, Antonio J. Marín, MA, Maribel Trejo, BS, Cecilia Ordaz Gudino, Jeannie Economos, and J. Antonio Tovar-Aguilar, PhD

Objective: The aim of this study was to determine the effectiveness of curricula for improving knowledge and attitudes pertaining to pesticide exposure and heat illness among immigrant Latino farmworkers. **Methods:** A pesticide safety curriculum informed by the revised Worker Protection Standard (WPS) was tested against an attention placebo-controlled curriculum (heat illness) in a sample of Latino farmworkers ($N = 127$). **Results:** Pesticide safety knowledge increased in the overall sample, but did not differ by curriculum assignment. Pesticide safety behavioral intentions increased among participants in the pesticide safety curriculum but decreased among those in the other curriculum ($P < 0.05$). Heat illness knowledge and behavioral intentions increased more for farmworkers assigned to the heat illness than the pesticide safety curriculum. **Conclusion:** The developed curricula show good promise for meeting the spirit of the revised WPS and for reducing the burden of heat-related fatality and morbidity among Latino farmworkers.

Keywords: EPA Worker Protection Standard, farmworkers, health-related illness, pesticide safety

Farmworkers, the vast of majority of whom are immigrants from Mexico, are a vulnerable worker population. Pesticide exposure and heat illness are among the top occupational health threats confronted by farmworkers. Arcury et al[1,2] clearly documented that the vast majority of farmworkers have evidence of exposure to multiple pesticides across the agricultural season. Although the health effects of chronic, low-dose exposure to pesticides are largely unknown, epidemiological research and that undertaken with animal models suggest that elevated pesticide exposure increases the risk of neurological conditions such as Parkinson disease[3,4] and fertility problems,[5,6] as well as a variety of cancers.[7,8] Whereas the health effects of pesticides are primarily long-term in nature, farmworkers are among the most at-risk worker populations for heat-related death while on the job. Indeed, whereas the average rate of heat-related fatality is 0.22 per 1 million workers in the general workforce, it is 3.06 in the agricultural sector,[9] a nearly 14-fold increased risk.

The United States Environmental Protection Agency (US EPA), after an extensive public comment period that included comments from farmworker advocates and other stakeholders,[10] revised the Worker Protection Standard (WPS) in 2015. The WPS is the only federal regulation designed to minimize farmworkers' exposure to pesticides by requiring worker training. The revised WPS required an expansion in the content of the required training, as well as changes to the timing and frequency of training. Previously, employers were required to provide training to workers at least once every 5 years, and the longest a farmworker could wait to be trained before beginning work in areas where pesticides were used was 5 days. The revised WPS requires an annual training before any work was done in the fields or greenhouses and the regulation requires pesticide health and safety training once a year. The majority of the provisions of the revised WPS became active in 2017 with the commencement of training with the updated curriculum required in 2018.

Throughout its 40-year existence, WPS training has occurred in two primary ways. The first and predominant mode of training was through educational video. The second primary delivery was through formal health and safety education sessions using an EPA-certified curriculum. Evaluations of WPS training, via either video or health educator, are notably absent from the peer-reviewed literature. Indeed, there are only three evaluations of WPS training in the literature. Anger et al,[11] using a single-sample, pre-posttest design reported an immediate change in Latino vineyard workers' knowledge about pesticides and strategies for minimizing pesticide exposure following a computer-disseminated WPS lesson. They also showed that a small proportion of that knowledge was retained across a 5-month period. Another evaluation using a similar single-sample pre-posttest design but using the *Pesticide and Farmworker Health Toolkit*, a curriculum approved by the U.S. EPA for meeting requirements of the original WPS, deployed via trainers reported similar results.[12] Vela Acosta et al[13] wait-list control design with pre-post assessment reported greater increases in pesticide knowledge and readiness to change pesticide-related behaviors among individuals receiving immediate education, featuring an EPA-approved WPS flipchart, relative to wait-list controls. Quandt et al[14] evaluation of *La Familia Sana*, a WPS-based curriculum focused on para-occupational exposure to pesticides deployed via a community health worker, found increases from pre- to posttest in knowledge and behaviors advocated by the WPS to reduce pesticide exposure. Otherwise, research on the WPS has largely been descriptive in terms of whether WPS training was provided with clear evidence that training was far from universal.[15–17] No evaluations of safety education programs designed to prevent heat illness among farmworkers could be located in the peer-reviewed literature.

Entrenamiento de Pesticidas e Insolación que es Culturalmente Apropiada (*PISCA*) was designed to provide a tool to effectively reduce poor occupational health outcomes among farmworkers. The central feature of the tool is two safety education curricula: one targeting pesticide exposure and the other heat illness. *PISCA* curricula were designed based on two fundamental principles. Foremost, following the early recommendations of Quandt et al,[18,19] both curricula (ie, WPS and Heat illness) were designed to maximize cultural appropriateness. Beyond simply translating the

From the Florida State University, Department of Family & Child Sciences, Tallahassee, FL (Dr Grzywacz, Dr Gonzales-Backen, Marín, Trejo, Gudino), Migrant Clinicians Network, Division of Environmental and Occupational Health, Salisbury, MD (Liebman), Farmworker Association of Florida, Apopka, FL (Economos, Dr Tovar-Aguilar).

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Address correspondence to: Joseph G. Grzywacz, PhD, Chair and Norejane Hendrickson Professor of Family & Child Sciences, 120 Convocation Way, Tallahassee, FL 32306. (jgrzywacz@fsu.edu).

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curricula into Spanish, the *PISCA* team was attentive to the reality that the average years of education among farmworkers is 6.2 years,[20] and cultural beliefs based in principles of humoral medicine[21] (eg, hot/cold imbalances) that may conflict with advocated safety behaviors (eg, shower immediately after work to reduce pesticides, submerge a heat stroke victim in water). Next, both curricula were designed to enhance contextual appropriateness through the use of images depicting dominant crops and work modalities in the region, and acknowledging potentially competing interests (eg, taking water breaks can impede production for those working piece-rate). Third, and specific to the pesticide curriculum, the content had to contain all requirements for EPA certification under the revised WPS.

The *PISCA* curricula were designed for typical safety outreach to farmworkers. The curricula consist of a facilitator guide that contains core learning objectives, scripts for delivering the material, and suggestions for facilitating participant involvement in learning. Each curriculum also has a Powerpoint presentation, including embedded video clips illustrating key are complex ideas. Facilitator guides and Powerpoint presentations are available in both English and Spanish, and were designed to be implemented in facilitator-led, live training of farmworkers in small groups (eg, 5 to 20). Indoor training venues are ideal given the necessity of a power-source for the computer and projector, but the curricula have been deployed in outdoor venues (ie, tents) with a power source by bringing a projector and a surface for projecting the presentation. The curricula have multiple opportunities for participant engagement, but the basic content of each curriculum can be delivered in 45 to 90 minutes. The pesticide safety curriculum contains all content necessary to comply with the revised WPS, and the heat illness curriculum covers basic physiology and common signs and symptoms of heat illness, simple strategies for preventing heat illness, and recommended steps in response to symptoms of heat illness.

PISCA's overall goal is to reduce the burden of poor occupational health outcomes among Latino farmworkers resulting from pesticide exposure and heat illness. The specific objective of this study is to determine the effectiveness of the PISCA curricula for improving knowledge and attitudes pertaining to pesticide exposure and heat illness. The evaluation makes two striking improvements to the literature to date. First, unlike any of the evaluations to date, we use a comparative design to compare pre- to posttest changes in farmworkers knowledge and attitudes. Second, we simultaneously address two occupational health threats (ie, pesticide exposure and heat illness).

METHODS

This study used an attention-placebo control design[22] to evaluate the effectiveness of the PISCA pesticide exposure (ie, WPS) and heat illness curricula simultaneously. The premise underlying the attention-placebo control design is that the basic act of drawing attention to something—like an occupational health issue—has the potential to create a placebo or Hawthorne effect. To differentiate a "true" effect from those resulting from "placebo," the attention-placebo control seeks to "mimic the activities of the active intervention group in time and degree or amount of contact with participants, but the selected activities are not related to the intervention content in that they do not contain the active ingredient of active intervention"[23] (p. 321). In the current application, the heat illness curriculum is an attention placebo-control for the pesticide curriculum because it mimics the attention received by participants in the active intervention (ie, involvement of a professional occupational safety trainer) and the amount of time in the intervention. However, the heat illness curriculum does not contain the "active ingredient" presumably needed to change pesticide knowledge, attitudes, and behavioral intention, specifically content about pesticides. Conversely, the pesticide curriculum is attention placebo-control for the heat illness curriculum because it mimics the attention received by participants and the amount of time in the intervention. However, the pesticide curriculum does not contain the "active ingredient" presumably needed to change heat illness knowledge, attitudes, and behavioral intention, specifically content about heat illness.

RECRUITMENT

All participants were recruited through a two-stage community-based procedure. Community Advisors, women who are known in the farmworker community and employed by the PISCA project, operated within their social networks and community enclaves to invite participants to a free safety education event. The Community Advisors did not know which curricula would be featured at each safety education event; they only knew the date, time, and location of the event. Community Advisors were allowed to let individuals know that they might be invited to participate in a study as part of the safety education event and that they would receive $15 if they were invited to participate in the study and they completed the assessments required by the study. Between March 26, 2017, and August 19, 2017, the PISCA team organized nine safety education events. This is the first of three phases for PISCA, wherein the primary focus was beta-testing the curricula. Consequently, the curricula underwent a minor evolution across the study sessions. The content of both curricula remained constant, but the study team did engage in continuous quality improvements by refining their delivery of concepts and elements the audience seemed to have difficulty with or regularly raised questions about throughout program delivery.

On the day of each event, as participants arrived every individual who self-identified as Latino and having worked in agriculture in the previous week upon "check-in" was invited to participate in the evaluation of the curricula. Individuals expressing an interest in participating were then directed to a PISCA team member who explained the details of the study, including the incentive for participating and obtained verbal informed consent. Nearly all (80.7%) individuals invited to the study agreed to participate.

DATA COLLECTION

All data were collected via a small group (eg, three to five) interviewer-assisted survey questionnaires conducted in Spanish by six trained data collectors. Farmworkers typically arrived at the safety education event individually but occasionally arrived in dyads or small groups. As individuals enrolled in the study, they were assigned to study staff member for data collection. The study staff member, all of whom were native Spanish-speakers to ensure language fluency and the help the farmworkers feel more comfortable, provided each member of the small group with a copy of the assessment and explained that she/he would read each question, and after doing so, would ask the participant to mark the most appropriate response. While participants were marking their response, the staff member observed whether participants were recording their answer to the question just asked and provided direction as needed. Likewise, if individuals were observed to have moved beyond the current question, they were asked to wait for the rest of the group.

MEASURES

Pesticide Knowledge, Attitudes, and Behavioral Intention

Pesticide knowledge was assessed with 22 true/false questions capturing several domains covered by the WPS curriculum. Questions included those related to knowing what pesticides are (eg, "Liquids used in fields to help plants grow are one of the most dangerous forms of pesticides to farmworkers."); primary routes by which pesticides enter the body (eg, ‘‘The main way that pesticides get into a farmworker’s body is through the skin.’’); health threats of pesticide exposure (eg, ‘‘Your exposure to pesticides can cause learning problems in your children.’’), as well as familiarity with standard re-entry interval signs, common field sanitization strategies for reducing pesticide exposure (eg, ‘‘Washing your hands ***before*** eating, using the bathroom, or smoking a cigarette reduces the chance for pesticides to get into your body.’’); and legal requirements of pesticide training (eg, ‘‘Your employer or contractor must make pesticide information available to all workers without requiring workers to request that information.’’). Items were scored such that ‘‘correct’’ answers were coded one, zero otherwise, and summed such that higher values indicated greater *pesticide knowledge*.

Two attitudes about pesticide were assessed. *Pesticide self-efficacy* was assessed with five items asked with a common stem (ie, ‘‘how confident do you feel about your ability to...’’) and ended with a discrete idea like ‘‘... practice behaviors during work that reduces or minimize exposure to pesticides?‘‘ or ‘‘...make requests for information about pesticides used in your work area?’’. Response options were ’’not at all,‘‘ ’’a little,‘‘ and ’’a lot.‘‘ Items were averaged with higher scores indicating greater efficacy ($\alpha = 0.67$ and 0.76 for the pre-test and post-test, respectively). Perceived threat of pesticides to workers’ health was assessed with four statements (eg, Pesticide exposure has a very little effect on my life’’ or ‘‘The results of pesticide exposure would cause significant difficulties for me and my family.’’). Individuals were asked to express either agreement or disagreement with the statements. The items were coded and averaged such that higher values indicated a greater *perceived threat of pesticides*. One item was omitted in order to improve reliability ($\alpha = 0.70$ and 0.65 for pre-test and post-test, respectively).

Behavioral intentions about pesticides were assessed with five items created to measure intended changes in workplace behaviors. The items asked, ‘‘In the next week, how likely is it that you will.....’’ with items like ‘‘wash your hands before eating?’’ or ‘‘take a shower and wash your hair immediately after finishing work?’’ following. Response options were ‘‘not at all,’’ ‘‘a little,’’ and ‘‘a lot.’’ Items were averaged with higher scores indicating greater *behavioral intention.* One item was omitted in order to improve reliability ($\alpha = 0.61$ and 0.55 for pre-test and post-test, respectively).

Heat Illness Knowledge, Attitudes, and Behavioral Intention

Heat illness knowledge was assessed with 17 true/false questions capturing several domains. Questions included those related to individual vulnerability to heat illness (eg, ‘‘Young children, older people, and pregnant women are better able to adapt to heat and humidity.’’); signs and symptoms of heat illness (eg, ‘‘Extreme thirst, a dry mouth, and lightheadedness are all symptoms of heat exhaustion.’’); first-aid responses to signs of heat illness (eg, ‘‘The best thing for a person suffering from heat exhaustion is an energy drink like Monster or Red Bull.’’); recommended water-intake to prevent heat illness (eg, To prevent dehydration, you should drink one cup of water every hour while working.’’); and legal requirements of workers (eg, ‘‘The law allows farm owners or contractors to make farmworkers pay the fair cost of having drinking water available.’’). Items were scored such that ‘‘correct’’ answers were coded one, zero otherwise, and summed such that higher values indicated greater *heat illness knowledge*.

Heat illness attitudes were assessed with parallel items described above for pesticide attitudes. *Heat illness self-efficacy* was assessed with five items asking ‘‘how confident do you feel about your ability to....,’’ with items like, ‘‘dress in a way that prevents heat illness, even on hot and humid days’’ following. Response options were ‘‘not at all,’’ ‘‘a little,’’ and ‘‘a lot.’’ Items were averaged with higher scores indicating greater efficacy ($\alpha = 0.76$ for pre-test and post-test). Perceived threat of heat illness was assessed with four statements (eg, ‘‘Experiencing heat illnesses, especially heat exhaustion or stroke, would not have much effect on my life.’’) and the individual was asked to express either agreement or disagreement. The items were coded and averaged such that higher values indicated a greater *perceived threat of heat illness*. One item was omitted to improve reliability ($\alpha = 0.62$ and .75 for pre-test and post-test, respectively).

Heat illness behavioral intention was assessed with five items created for this study. The items asked, ‘‘In the next week, how likely is it that you will...,’’ with, for example, items like ‘‘drink 2 gallons of water per day during your work day?’’ or ‘‘take breaks in the shade if I experience heat symptoms?’’ following. Response options were ‘‘not at all,’’ ‘‘a little,’’ and ‘‘a lot.’’ Items were averaged with higher scores indicating greater *behavioral intention.* One item was omitted to improve reliability ($\alpha = 0.69$ and 0.62 for pre-test and post-test, respectively).

Several individual characteristics were assessed and used as covariates, including *age* (in years), *sex* (male or female), *country of birth*, the *highest level of completed education* (primary, secondary, preparatory, GED, beyond high school), and *English-speaking fluency* was assessed as an indicator of acculturation. Participants were also asked how many years they had performed farm work in the U.S. (in years), whether they self-identified as a *migrant* (‘‘I move place-to-place to perform farm work’’) or *seasonal* (‘‘I live here year-round and perform farm work when it is available’’), and whether they had participated in *WPS* or *heat illness* training in the past year.

Analytic Plan

Preliminary analyses were performed to assess participants’ level of pesticide knowledge and heat stress knowledge at baseline. We examined frequencies of correct and incorrect responses to each item of the pesticide and heat stress knowledge measures. Results identified seven items on each measure on which 90% or more of participants responded correctly at the pre-test. Because these items captured little variability in baseline pesticide and heat stress knowledge, they were omitted from each measure, resulting in a 15-item measure of pesticide knowledge and an 11-item measure of heat stress knowledge.

Mean differences in knowledge, attitudes, and behavioral intention assessments between study conditions (ie, pesticide vs heat illness curricula) were compared using one-way analysis of variance (ANOVA). The condition (ie, pesticide vs heat illness curricula) was entered as the factor and each assessment of knowledge, attitude, and behavioral intention was entered as the dependent variable. Next, repeated-measures multivariate ANOVA models were fit to examine differences between the study conditions (ie, pesticide vs heat illness curricula) in the change from pre-test to post-test, controlling for demographic characteristics that varied between groups. For each study variable, pre-test and post-test were entered as the factors. Study condition was entered as the between-subjects factor. Gender, years in farm work, type of worker (ie, migrant or seasonal), and completion of a workplace safety training in the past year were entered as covariates.

RESULTS

Study participants included 127 Latino farmworkers (Table 1). Like most farmworker samples, participants were primarily male, although nearly one-third (31.5%) was female. All participants were born outside of the United States with 96.1% born in Mexico and the remaining 3.9% born in other Central and South American countries. Participants were 32.7 ($SD = 10.4$) years old on average and had been working in farm work for an average of

TABLE 1. Descriptive Statistics for PISCA Study Participants, by Exposure to Curricula

	Sample		WPS Curricula		Heat Illness Curricula		
	N	%	*N*	%	*N*	%	*P*
Personal characteristics							
Age, years							0.589
18–25	31	28.70	16	34.78	15	24.19	
26–35	45	41.67	18	39.13	27	43.55	
36–45	19	17.59	6	13.04	13	21.97	
46–55	9	8.33	4	8.70	5	8.06	
55+	4	3.70	2	4.35	2	3.23	
Sex							0.085
Male	87	68.50	40	61.54	47	75.81	
Female	40	31.50	25	38.46	15	24.19	
Country of Birth							0.690
Mexico	122	96.06	62	95.38	60	96.77	
Other	5	3.94	3	4.62	2	3.23	
Educational Attainment							0.705
Primary (<6th grade)	44	34.46	24	36.92	20	32.26	
Secondary (7th–9th grade)	51	40.16	24	36.92	27	44.55	
Preparatory (10th–12th grade)	28	22.05	13	20.00	15	24.19	
General Equivalency Degree	2	1.57	2	3.08	0	0.00	
Some college or higher	2	1.57	2	3.08	0	0.00	
English-speaking Fluency							0.566
Little or none	112	88.19	59	90.77	53	85.48	
More or less/Conversational	13	10.24	6	9.23	7	11.29	
Bilingual	2	1.57	0	0.00	2	3.23	
Work-related characteristics							
Years in US farm work							0.003
<3 years	59	46.46	35	53.85	24	39.34	
3–5 years	18	14.17	14	21.54	4	6.56	
6–10 years	30	23.62	8	12.31	22	35.48	
>10 years	20	15.75	8	12.31	12	19.67	
Type of worker							0.001
Migrant	83	65.35	51	78.46	32	51.61	
Seasonal	44	34.65	14	21.54	30	48.39	
Training in the past year							
WPS	36	28.35	9	13.85	27	43.55	<0.001
Heat illness	27	21.26	8	12.31	19	30.65	0.001

6.1 years (SD = 6.5). Participants assigned to the heat stress condition had significantly more experience in farmwork than those in the pesticide condition [$F(1, 124) = 9.3$, $P < 0.01$]. Most participants were migrant workers (65.4%) and most had not had a WPS pesticide safety training (71.7%) or a heat stress safety training (78.7%) in the past year. Participants assigned to the heat stress condition were more likely to be seasonal workers [$F(1, 125) = 10.8$, $P < 0.01$], have had WPS pesticide safety training [$F(1, 53) = 54.9$, $P < 0.001$] or heat stress safety training [$F(1, 53) = 11.2$, $P < 0.01$] in the past year, compared with those in the pesticide condition. Participants in each condition did not significantly differ on other characteristics.

At pretest, pesticide knowledge did not differ between participants assigned to the WPS pesticide curriculum compared with those assigned to the heat illness curriculum [$F(1, 125) = 0.33$, $P = 0.57$] (Table 2). However, by posttest, participants in the WPS pesticide curriculum reported marginally higher pesticide knowledge than those in the heat illness curriculum [$F(1, 125) = 3.68$, $P = 0.057$]. At pretest, participants in the heat illness curriculum did report significantly higher behavioral intentions related to pesticide safety compared with those assigned to the WPS pesticide curriculum [$F(1, 125) = 4.16$, $P < 0.05$], but this difference was attenuated to non-significance at the post-test [$F(1, 125) = 0.11$, $P = 0.74$]. There were no other significant mean-level differences between the study conditions in pesticide safety-related attitudes or behavioral intentions.

Knowledge of heat illness at pretest was higher among participants assigned to the heat illness curriculum than those assigned to the WPS pesticide curriculum [$F(1, 125) = 6.80$, $P < 0.05$] (Table 3). This pre-test difference widened at the post-test [$F(1, 125) = 25.04$, $P < 0.001$]. At the pre-test, there were no significant differences between the study groups in behavioral intentions related to preventing heat illness [$F(1, 125) = 1.39$, $P = 0.24$]. At the post-test, participants in the heat illness curriculum reported significantly greater behavioral intentions to prevent heat illness than those in the WPS pesticide curriculum [$F(1, 125) = 11.78$, $P < 0.01$]. There were no other significant mean-level differences between study conditions in heat illness-related attitudes or behavioral intentions.

Multivariate analysis of covariance models (MANCOVA) was fit to test differences between study conditions (ie, pesticide versus heat illness curriculum) in change from pre-test to post-test in pesticide knowledge, attitudes, or behavioral intentions. Gender, years in farm work, type of worker (ie, migrant, seasonal), and whether participants had taken a work safety course in the past year were all included as covariates in these models. Pesticide safety knowledge significantly increased from pre-test to post-test in the overall sample [$F(1, 120) = 6.79$, $P < 0.05$], but did not differ for farmworkers assigned to the pesticide safety curriculum relative to those assigned to the heat illness curriculum [$F(1, 120) = 0.09$, $P = 0.77$]. Similarly, perceived threat of pesticides significantly

TABLE 2. Pre- and Posttest Values of Pesticide-related Knowledge Attitudes and Behavioral Intention

	WPS Curricula		Heat Illness Curricula		
	M	SD	M	SD	*P*
Pesticide knowledge					
Pretest	51.00	15.06	50.54	13.42	0.565
Posttest	59.08	13.84	54.30	14.22	0.057
Pesticide self-efficacy					
Pretest	7.42	1.86	7.81	1.82	0.234
Posttest	8.20	1.86	8.16	1.90	0.908
Perceived threat of pesticide					
Pretest	0.77	0.34	0.81	0.29	0.451
Posttest	0.84	0.28	0.85	0.27	0.863
Pesticide behavioral intention					
Pretest	1.67	0.43	1.81	0.32	0.043
Posttest	1.73	0.34	1.75	0.35	0.741

increased from pre-test to the post-test in the total sample [$F(1, 120) = 8.42$, $P < 0.01$], but did not differ by study condition [$F(1, 120) = 0.11$, $P = 0.74$]. Behavioral intentions related to pesticide safety did not change in the total sample; however, change significantly differed by study condition [$F(1, 120) = 5.07$, $P < 0.05$]. As shown in Fig. 1, reported behavioral intentions related to pesticide safety increased among participants in the WPS pesticide safety condition but decreased among those in the heat illness safety condition. In summary, the overall pattern of results is that knowledge and attitudes about pesticides increased for all participants, regardless of curriculum received. Only pesticide-behavioral intention changed in a manner specific to the curriculum received.

Results from MANCOVA models examining differences between study conditions in change from pre-test to post-test in heat illness safety knowledge and attitudes indicated that heat illness knowledge increased from pre-test to post-test in the overall sample [$F(1, 120) = 4.27$, $P < 0.05$]. Further, this change differed by study condition [$F(1, 120) = 3.84$, $P < 0.05$] such that heat illness knowledge increased from pre-test to post-test among participants in the heat stress safety condition, but remained constant among those in the WPS pesticide safety condition (Fig. 2). Behavioral intentions related to heat illness did not change from pre-test to post-test in the overall sample [$F(1, 120) = 2.50$, $P = 0.12$]; however, there was a significant difference by condition [$F(1, 120) = 5.28$, $P < 0.05$]. Among participants in the heat illness curricula, behavioral intentions related to heat illness increased from pre-test to post-test. By contrast, among participants assigned to the WPS pesticide safety curricula, behavioral intentions related to heat illness did not change (see Fig. 3). In summary, heat illness knowledge and behavioral intention changed in a manner specific to the curriculum received, that is, change in knowledge and behavioral intention about heat illness were significantly elevated for those receiving the heat illness curriculum relative to those who received the WPS curriculum.

DISCUSSION

Pesticide exposure and heat illness are among the top occupational health threats confronted by farmworkers, the vast majority of which are immigrants from Mexico. The primary objective of this study was to determine the effectiveness of the PISCA curricula for improving knowledge, attitudes, and behavioral intentions pertaining to pesticide exposure and heat illness. The PISCA curricula have two noteworthy characteristics. First, the PISCA curriculum was designed to comply with all required educational components of the revised WPS. This study is novel in that it is the first culturally adapted WPS curricula to be subjected to evaluation, under either the old or new WPS. A second noteworthy feature of the PISCA curricula is that it takes recommendations seriously about the need for culturally and contextually appropriate safety education materials.[18,19] The results from this Phase I evaluation of the PISCA curricula are promising and make several contributions to the literature.

PISCA study results contribute to the small body of studies evaluating WPS-based curricula among immigrant farmworkers.[10–12] Contrary to two other studies using single-sample designs without a

TABLE 3. Pre- and Posttest Values of Heat Illness Related Knowledge Attitudes and Behavioral Intention

	WPS Curricula		Heat Illness Curricula		
	M	SD	M	SD	*P*
Heat illness knowledge					
Pretest	21.96	6.20	24.63	5.31	0.010
Posttest	22.10	6.22	26.39	2.71	0.000
Heat illness self-efficacy					
Pretest	7.38	2.18	7.90	1.91	0.157
Posttest	8.45	1.57	8.63	1.53	0.508
Perceived threat of health illness					
Pretest	0.83	0.25	0.88	0.26	0.351
Posttest	0.88	0.26	0.92	0.22	0.388
Heat illness behavioral intention					
Pretest	1.55	0.45	1.64	0.37	0.240
Posttest	1.58	0.44	1.80	0.28	0.001

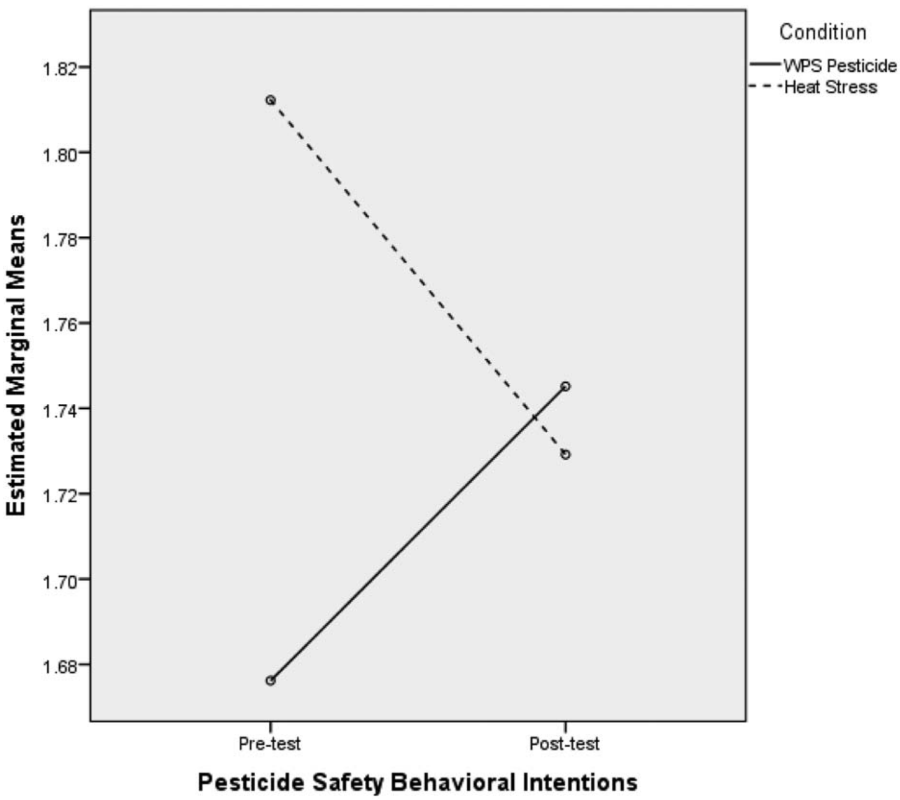

FIGURE 1. Estimated marginal means of pesticide safety behavioral intentions by study condition.

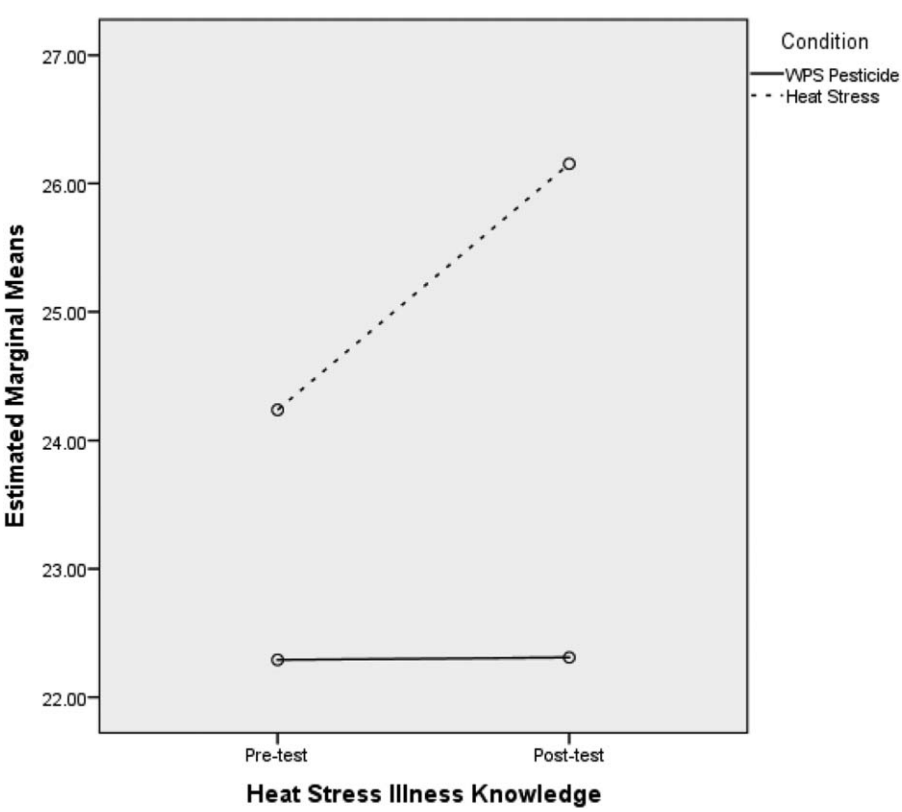

FIGURE 2. Estimated marginal means of heat illness knowledge by study condition.

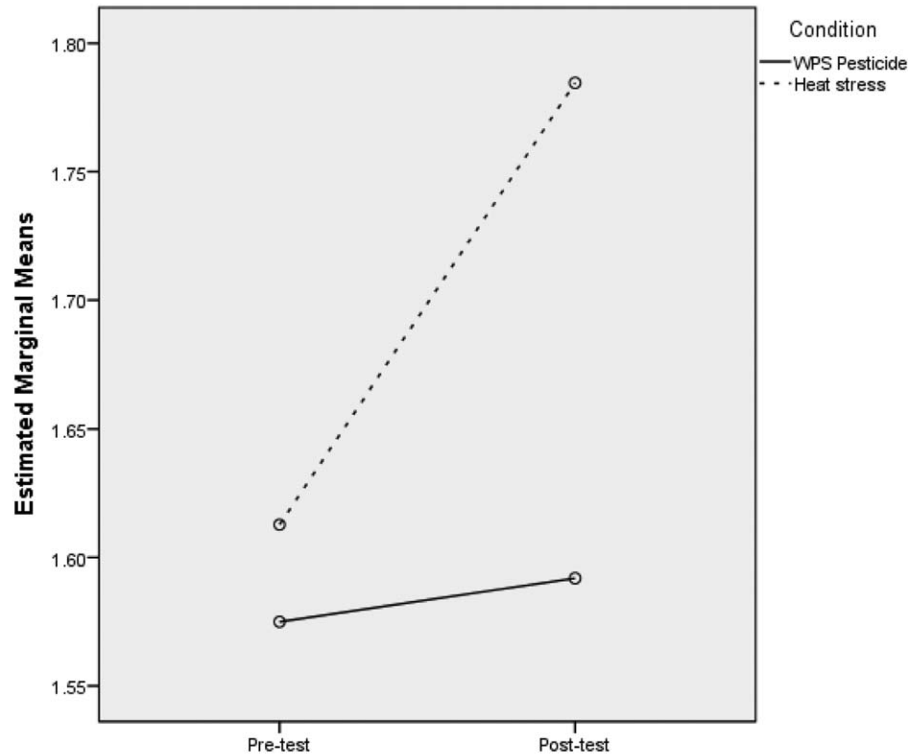

FIGURE 3. Estimated marginal means of heat illness behavioral intentions by study condition.

comparison group,[11,12] the *PISCA* pesticide safety curriculum was not found to be more effective than the attention-placebo curriculum (ie, heat illness) in promoting knowledge about pesticide safety; however, the PISCA pesticide safety curriculum was more effective than the attention placebo condition in promoting behavioral intentions to practice pesticide safety behaviors. Vela Acosta et al,[13] who used a wait-list control design, found their WPS-based intervention to promote both pesticide knowledge and behavioral intentions. It is unclear why the PISCA curriculum was not found to increase pesticide knowledge. On one hand, simple pre-test to post-test comparisons suggest knowledge may have increased (ie, [$F(1, 125) = 3.68$, $P = 0.057$]), and there was clear evidence of changes in behavioral intention, suggesting some potential utility for the new curriculum. On the other hand, the observed increase in pesticide knowledge was not greater than a similar (albeit statistically nonsignificant) increase in pesticide knowledge among those assigned to the heat illness curriculum suggesting the possibility of a placebo effect.[24] That is, by simply drawing attention to any aspect of occupational safety and health, participants in both the pesticide and heat illness conditions may have become more attentive to the phenomenon, thereby allowing improvements in observed pesticide knowledge scores. This pattern of results, although suggestive of the potential benefit of the PISCA pesticide safety curriculum, highlights the importance of strong controls for study participants' attention and expected benefits of educational interventions.[22,25] The PISCA pesticide safety curricula may need further refinement to meet the spirit of the revised WPS, or more precise assessment instruments may be needed to effectively evaluate the curriculum.

The results of this study clearly demonstrated the potential occupational safety and health value of the PISCA heat illness curriculum for Latino farmworkers. Relative to farmworkers assigned to the PISCA pesticide safety curriculum, those assigned to the PISCA heat illness curriculum showed greater improvements in knowledge about heat illness as well as greater changes in intention to engage in behaviors to prevent heat illness. It is noteworthy that heat illness knowledge changed for participants in both conditions, suggestive of a potential placebo effect.[24] Nevertheless, this is the first study we could locate that evaluated an educational intervention in promoting farmworkers' knowledge and behavioral intentions related to heat illness. Nevertheless, the results are consistent with previous studies demonstrating that purposeful occupational safety and health outreach can promote knowledge and associated psychological antecedents underpinning safe behavior while performing farmwork.[10–12] In the specific context of heat illness, such outreach is needed recognizing that farmworkers are over 10 times more likely than workers in other sectors to die from heat illnesses.[9]

The third contribution of this study rests in its approach, namely, the use of an attention placebo control design to evaluate the pesticide safety and heat illness curricula is novel. Attentional placebo control designs are commonly used in psychiatric or brain-related treatments[26–29] and have been encouraged for more psychosocial interventions,[22] including educational interventions. As Gross[25] contends, an important ingredient of effective evaluation is mindfulness to improvements in desired outcomes that can be attributed to participants expectations and the attention they receive through the intervention. Although the *Hawthorne Effect* typifies the potential power of participants expectations and attention, it is uncommon for interventions—particularly those in studies of behavior—to fully account for these forces. We contend that the results of the current study are robust against the participants expectations and attention because it took about the same length of time to deliver both curricula (ie, approximately 90 minutes), the delivery context was highly similar (ie, groups of farmworkers in community-based sites), and pre-test and post-test assessments focused on the exact same content. Moreover, we suggest that the attention placebo-controlled design is both practically and ethically superior to other intervention designs used to evaluate occupational safety and health interventions among farmworkers. A wait-list control strategy is practically challenging, particularly in the context of pesticide safety training, because the WPS requires all farmworkers to be trained before beginning work in the fields. Few owners/operators and even fewer workers will likely participate in evaluation research if it means lost production time. In terms of ethically superior, the attention placebo-controlled design like that implemented in this study allowed simultaneous evaluations of strategies targeting the primary threats to farmworker occupational health. Each study participant received something valuable, while also answering an important scientific question.

The contributions of this study need to be interpreted within the context of its limitations. It is clear that the participants in each condition were not the same. Despite efforts to be nonsystematic in attracting farmworkers to the free safety education events, the individuals who received the pesticide safety curriculum were more likely to be migrant and to have spent less time in the U.S., which may have resulted in their being less likely to have reported experiencing previous pesticide safety and heat illness training. Although controlled for in our final models, unbalance due to these demographic and occupation-specific factors may have biased study results. Second, the sample for this study is from a narrow region of southeast GA and northeast FL and was not randomly drawn; consequently, the generalizability of the results is unclear. Third and finally, because this project was essentially a beta-test for a broader evaluation, the curricula underwent minor evolution across the study. The content of both curricula remained constant across this implementation; however, the study team did ''tweak'' concepts and elements the audience seemed to have difficulty with or raised questions about throughout program delivery. To be clear, pre-test and post-test data were not considered in this process; nevertheless, the continuous quality improvement approach taken to curricula delivery may have contributed to the observed positive results.

Limitations notwithstanding, the results of this study advance the science and practice of protecting occupational safety and health among Latino farmworkers. The results of this study demonstrate that pesticide safety curriculum developed for PISCA to comply with the revised WPS may be useful for promoting pesticide knowledge, and are useful for stimulating intentions to engage in behaviors that minimize exposure to pesticides. Likewise, the results demonstrate the heat illness curriculum developed for PISCA is effective in promoting knowledge about heat illness and its prevention, while also stimulating intentions to engage in behaviors that lessen the risk for heat illness. These results, buttressed by a strong and arguably practically and ethically superior attention placebo-control design, suggest the PISCA curricula are useful for improving knowledge and attitudes pertaining to pesticide exposure and heat illness and may be useful tools for protecting immigrant Latino farmworkers from the dominant health threats confronted through their work.

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