

**The Role of Acculturation and Training in Personal Protective Equipment (PPE) Use
among Hispanic Farmworkers:
A Follow-up from the ¡Protejase! Study**

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Abstract

Hispanic farmworkers are at disproportionate risk of pesticide exposure. Moreover, new immigrant, Spanish-speaking farmworkers are least likely to receive safety training and protection from pesticides in the form of personal protective equipment (PPE). Provision is known to increase PPE use among farmworkers, but it is unclear whether provision helps new immigrant Hispanic farmworkers. Thus, this study examined the extent to which provision increases Hispanic farmworkers' use of PPE. Additionally, we examined associations with English language acculturation since language barriers might influence training and use of PPE in a largely new immigrant, Spanish-speaking workforce. Farmworkers were provided three types of PPE (chemical-resistant gloves, safety glasses, and long-sleeved shirts) as part of the ¡Protejase! study. We assessed differences in the use of PPE that was provided by the ¡Protejase! study compared to PPE that farmworkers were not provided. We also measured workers' English language acculturation, training, and other work demographic variables. PPE use was measured at baseline and after 30 days, and analyzed using OLS regression. Use of study-provided PPE was significantly higher, but only among participants with low levels of English language acculturation ($p < .05$). Thus, providing PPE increases its use among farmworkers with low levels of English language acculturation.

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Unmitigated pesticide exposures can have significantly negative effects on the health of farmworkers. The consequences of pesticide exposures can include dizziness, headache, uncontrolled sneezing, vomiting, and/or diarrhea, and can extend to chronically raised blood pressure (Saw, Shumway, & Ruckart, 2011; Villarejo et al., 2010). Over the long-term, occupational exposures to pesticides are associated with increased risk of diabetes (Montgomery, Kamel, Saldana, Alavanja, & Sandler, 2008; Paul et al., 2018; Starling et al., 2014), Parkinson's disease (Lesmes-Fabian, 2015; Furlong et al., 2015), respiratory illness (Hoppin, Long et al., 2012; Hoppin, Umbach et al., 2014; Hoppin, Valcin et al., 2007), and several forms of cancer (Alavanja & Bonner, 2012; Alavanja, Hoppin, & Kamel, 2004).

Importantly, adverse health effects associated with such exposures for farmworkers can be mitigated through several pesticide protective behaviors, as well as compliance with federal prevention-based policies set forth by the EPA's Worker Protection Standard (WPS). The Standard is aimed toward harm reduction among the nearly 2 million farmworkers who are exposed to pesticides each year, and among the 300,000 of those cases which require hospitalization (United States Environmental Protection Agency, 2015). It has five primary components: 1) all farmworkers must undergo basic training about pesticide risks, and about general pesticide safety; 2) farmworkers must be notified about pesticide-treated areas, 3)

employees must adhere to pesticide label-specified waiting periods before entering areas treated with pesticides; 4) farmworkers may only enter areas before the specified waiting period in exceptional circumstances, and employers must provide special protections for such workers regarding training, instructions, decontamination supplies, and personal protective equipment (PPE); and 5) all persons who come in direct contact with pesticides (mix, load, apply) must be supplied PPE in order to provide barrier protection between pesticides and the body (United States Environmental Protection Agency, 2015).

Even though the EPA-based policies are in place, farmworkers who prepare and harvest crops may come into contact with pesticide residues during regular crop maintenance. Farmworkers may also come into unintentional but regular contact with pesticides through drift of aerosol pesticides from nearby fields (Coronado et al., 2011; Damalas & Eleftherohorinos, 2011; Villarejo & McCurdy, 2008). Mitigation of the latter forms of exposure may be achieved through the use of decontamination sites where farmworkers can clean affected areas with soap and water, or through wearing baseline pesticide protective equipment to minimize skin contact with residue at work (such as long-sleeved shirts, long pants, and work boots) (Fenske, Lu, Negrete, & Galvin, 2013; Strong, Thompson, Koepsell, & Meischke, 2008). In fact, much research demonstrates that by employing the use of a combination of long sleeves, long pants, shoes, and a hat as baseline pesticide protective equipment use, harvesters and maintenance workers are able to significantly reduce their exposures to pesticides (Hernandez-Valero, Bondy, Spitz, & Zahm, 2001; Quandt et al., 2006; Salvatore et al., 2008). Additionally, individual pesticide protective behaviors such as the use of gloves, wearing long sleeves, and wearing boots have been found to be effective in decreasing pesticide exposures (Furlong et al., 2015; Salvatore et al., 2008). Thus, evidence shows that wearing baseline PPE such as long pants, a long-sleeved shirt, safety glasses, and gloves significantly reduces dermal route pesticide exposure among harvest and crop workers alike (Salvatore et al., 2008; Salvatore et al., 2009). Therefore, while we recognize that PPI provision is only required among farmworkers who reenter a field within the hazard interval, or those who mix, load, and apply pesticides, growing evidence suggests that the use of baseline PPE among harvesters and maintenance workers significantly reduces their exposure to pesticides (Hernandez-Valero et al., 2001; Quandt et al., 2006; Salvatore et al., 2008).

Epidemiologic and observational studies, however, have not provided a clear picture of the reasons farmworkers may or may not engage in protective behaviors, including PPE use (Levesque, Arif, & Shen, 2012; Walton et al., 2016). Although self-protective worksite behaviors like the use of PPE are a well-accepted way to decrease exposure (Bradman et al., 2009; Fenske, Blacker, Hamburger, & Simon, 1990; Salvatore et al., 2009), many farmworkers report that it is difficult and impractical to use (Snipes et al., 2009), believe that wearing PPE is uncomfortable or hot (Quiller et al., 2017), and argue that using protective equipment slows the productivity of work (Arcury, Quandt, Cravey, Elmore, & Russell, 2001; Quandt, Elmore, Arcury, & Norton, 2001; Snipes, Thompson et al., 2009; Strong et al., 2008). For example, Quandt, et al. (2001) reported that almost half of 197 farmworkers did not wear safety glasses because they prevent workers from distinguishing among leaf color of plants during harvest, and that not being able to do so could result in lower production among farmworkers who are paid by yield.

The degree of success of PPE as a solution for pesticide safety may also depend on the provision of such equipment, as evidence suggests that farmworkers rarely use PPE unless it is provided. Furthermore, using data from a sample of Hispanic workers, Strong et al. (2008) showed that even when employers were legally required to provide PPE, only 41.8% of

farmworkers were provided with it (Strong et al., 2008). Moreover, ethnic disparities exist. Strong et al. reported that just 36.8% of Hispanic workers are provided with PPE when required, compared to 83.3% of non-Hispanic white workers (Strong et al., 2008).

Workplace training is equally important. Individuals who understand workplace training content are more likely to use protection (Arcury, Marín, Snively, Hernández-Pelletier, & Quandt, 2009; Strong et al., 2008, Strong, Thompson, Koepsell, Meischke, & Coronado, 2009). The use of PPE is also associated with the language in which workplace training is offered. However, because the majority of farmworkers are immigrants (Carroll, Samardick, Bernard, Gabbard, & Hernandez, 2005) their levels of language acculturation may also determine the degree to which workplace training is understood. Thus, this paper draws on the theoretical framework of acculturation, defined as a process of socio-behavioral and linguistic changes that result from interactions between immigrant and host cultures over time (Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987). We believe that acculturation may be an important focal area in understanding the lack of PPE use, inadequacy of training, language in which workplace training is offered, and length of agricultural work among immigrant and immigrant-descendant workers. Our questions draw on the work of Farquhar and colleagues (2008), who suggested that new immigrant farmworkers are least likely to ask for PPE due to fears of retribution, language barriers, or both (Farquhar, Shadbeh, Samples, Ventura, & Goff, 2008). Language is another important factor, as Hispanic workers are less likely to be provided with PPE when they communicate in Spanish (Strong et al., 2008). Moreover, employers often have limited ability to train Spanish-speaking workers in the use of PPE because training programs typically are administered in English.

Moreover, there is little scholarly guidance on acculturation as an influence on farmworkers' use of PPE. Provision of PPE may remove barriers for employers who lack Spanish language skills and thus have limited ability to communicate with their Spanish-speaking staff, as well as protect a broader set of workers than are protected under current policies. Thus, the objective of this paper was to examine the relationship between the provision of PPE to farmworkers and PPE use, and whether the level of English language acculturation moderates this relationship. We suggest that language acculturation is an important factor affecting PPE use among Spanish-speaking immigrant farmworkers. Specifically, we hypothesized that farmworkers with low levels of language acculturation benefit most from PPE provision.

Methods

We provided participants with three PPE items (i.e., gloves, long-sleeved shirts, and safety glasses) that had been user-tested for functionality and comfort in a previous study as part of the ¡Protejase! study (Snipes et al., 2016). To model an environment in which PPE is recommended but not provided (i.e., workers must provide PPE themselves), we did not provide long pants, boots, and head coverings. We assessed items using a face-to-face administered survey. Measures compared total use of study-provided PPE (gloves, shirts, and glasses) and participant-provided PPE (pants, boots, and head coverings) at baseline and after 30 days. More information on PPE from the ¡Protejase! study can be found elsewhere (Snipes, Smyth, Murphy, Miranda, & Ishino, 2015).

Recruitment and Human Subjects Protection

We recruited participants at four community meetings of the Texas Migrant Council, an organization which sponsors the South Texas Migrant and Seasonal Farmworker Head Start along the Texas-Mexico border. The organization also has a 10-year research relationship with the principal investigator. At each meeting, study personnel explained the study's purpose and eligibility requirements (i.e., currently engaged in agricultural fieldwork and at least 18 years old). Individuals who expressed interest and met the inclusion criteria provided their names and phone numbers to be enrolled in the study.

Participation in the study was free and voluntary, with the right to stop participating at any time. The study protocol and procedures were approved by the Human Subjects Review Board at Penn State University (No. 00041419). We obtained written informed consent in Spanish or English, depending on each participant's preference. We gave each enrolled participant a \$15 Walmart gift card at the end of the study and participants were allowed to keep the PPE after the study concluded. We obtained human subject approvals prior to study initiation.

Measures

PPE use. We measured PPE use using a 5-point scale for gloves, safety glasses, long-sleeved shirts, long pants, boots, and head coverings/hats. For example, to measure glove use, we asked "How often do you wear gloves?", with five possible response options: (1) never; (2) 1 day per week; (3) 2 to 3 days per week; (4) 4 to 5 days per week; and (5) always. We based survey items largely on measures recommended by Quandt et al. (2006). Study participants answered the same questions at baseline and after 30 days.

To understand the role of PPE provision, we measured two categories of PPE use: 1) study-provided PPE use (gloves, glasses and shirts); and 2) farmworker-owned PPE use (pants, boots, and headwear). To measure study-provided PPE use, we combined and averaged the scores for gloves, safety glasses, and long-sleeved shirts. To measure farmworker-owned PPE use, we combined and averaged the scores for pants, boots, and head coverings. We compared combined scores of study-provided PPE to farmworker-owned PPE over 30 days.

Language acculturation. The main independent variable of interest was language acculturation, which we measured using the language subscale of the Short Acculturation Scale for Hispanics (SASH), (Marin et al., 1987), which has both social and language acculturation subscales. The SASH has been previously used in samples of Hispanic workers (Ellison, Jandorf, & Duhamel, 2011; Grzywacz, Rao, Gentry, Marin, & Arcury, 2009). We included the items on language use (i.e., language used by individuals to speak and think: 5 items). Participants rated their acculturation levels on a 5-point scale ranging from (1) only Spanish to (5) only English.

Original reliability scores (alpha coefficients) for the SASH items used in this study were .90 for the language subscale. Original instructions for the SASH suggest that responses can be averaged across items. An average of 2.99 should be used to differentiate less acculturated respondents (average scores between 1 and 2.99) from more acculturated respondents (average scores above 2.99). We averaged total SASH scores and categorized them using binary indicators for "moderate" or "low" acculturation since no participants in the study had high levels of language acculturation (i.e., no respondent answered "only English" on any single item).

Covariates. Control variables included farmworker safety training in the past 5 years (1 = yes), gender (1 = male), a continuous measure of the number of years spent working in agriculture, and an ordinal measure of household income with three possible responses: (1) less than \$10,000; (2) \$10,000 to \$14,999; and (3) \$15,000 to \$24,999. In addition, we assessed age, the number of years working in agriculture, education, and sex/gender.

Analysis

Randomization of participants to a control group was not acceptable to our community research partner. To address their concern, we used a within-person pre/post-test design over a 30-day period, allowing each worker to serve as his or her own control.

To analyze the data, we stratified descriptive characteristics by language acculturation and performed two-tailed *t*-tests to examine differences between means and tests of proportions to examine significant differences in categorical items. We performed Wilcoxon-Mann-Whitney tests when the number of observations fell below the level necessary to make an assumption of normality. Then, we assessed missing values to determine our next step in the analysis. There were relatively few missing values for the majority of indicators; to address these, we implemented a multiple imputation strategy using the MI command in STATA 12. An examination of mean differences revealed that descriptive findings did not change after imputation. Next, we ran six OLS regression models to assess differences before and after PPE provision, as well as the change in PPE use after provision. We measured the change in PPE use using the following formula: $PPE_UseChange = PPE_UseBefore_Provision - PPE_UseAfter_Provision$. Moreover, we examined whether acculturation played a moderating role in the relationship between PPE provision and training and the relationship between PPE provision and PPE use by examining findings by language acculturation.

Results

A total of 55 farmworkers were enrolled at baseline, but only 41 completed the entire study. All participants identified as Hispanic or Latino, with the majority of participants identifying as Mexican or Mexican-American; 39 (95%) were born in Mexico and spoke Spanish as their primary language. Other descriptive characteristics of the study population are shown in Table 1. Demographic and work characteristics of the sample did not vary significantly between baseline and follow up.

Table 2 shows descriptive characteristics by level of English language acculturation. When stratified, participants with lower language acculturation showed significant differences in income and use of study-provided PPE before and after provision when compared to individuals with moderate language acculturation. After provision, however, participants with low language acculturation had an average PPE use rating of 4.5 (almost always wearing provided PPE). Participants with moderate language acculturation showed no significant change in the use of gloves, safety glasses, and long-sleeved shirts before and after provision. Among the covariates, only income was significantly associated with differences in PPE use ($p = .019$) between low and moderately acculturated workers.

Table 3 displays the regression results for use of both the intervention-provided and farmworker-provided PPE at baseline and follow-up, and the change in PPE use. Low language acculturation is significantly associated ($p < .01$) with low use of the provided PPE at baseline before and after controlling for income, gender, and number of years working in agriculture. At

follow-up, however, this significant difference is no longer present. The change in PPE use panel reveals that low language acculturation is significantly associated with a 1.12 point increase ($p < .05$) in the use of study-provided PPE. This means that after 30 days, survey responses of participants with low English language acculturation levels, on average, increased by 1 point on the five-point Likert scale (e.g., from never to 1 day a week, or from 4 to 5 days a week to always), relative to participants with moderate English language acculturation levels.

Table 1

Demographic and Work Characteristics of the Population

	Baseline		Follow-up	
	<i>n or Mean</i>	<i>% or SE</i>	<i>n or Mean</i>	<i>% or SE</i>
Language				
Spanish	52	95	39	95
English	3	5	2	5
Sex				
Male	31	56	23	56
Female	24	44	18	44
Place of Birth				
Mexico	48	87	39	95
United States	7	13	2	5
Age				
< 20	3	5	1	2
21 – 30	28	51	22	54
31 – 40	14	26	11	27
41 +	8	15	6	15
Don't Know/Refused	2	3	1	2
Education completed				
≤ 8 th grade	24	44	17	44
9 th - 11 th grade	13	24	10	23
12 th grade or GED	12	22	10	23
Some college baccalaureate	3	6	2	5
Don't Know	3	4	2	5
Annual Income				
< \$10,000	28	51	21	51
\$10,000 - \$14,999	10	18	8	20
\$15,000 - \$24,999	5	9	3	7
Don't know	12	22	9	22
Employer-Provided Training				
Yes	22	40	19	47
No	26	47	21	51
Don't Know	7	13	1	2
Years Working in Agriculture	11.4	1.66	10.15	1.08

Discussion

The intervention increased the use of PPE among Hispanic farmworkers. Workers with lower levels of English language acculturation increased their use of PPE more than workers with moderate levels of English language acculturation. These results suggest that farmworkers with lower levels of English language acculturation at baseline benefited most from the provision of PPE because their use of provided PPE improved significantly, reaching levels similar to

workers with higher levels of English language acculturation. Specifically, farmworkers with low levels of English language acculturation may increase their use of PPE and protection from pesticide exposure when PPE is provided, thereby improving safety and health.

Other studies have demonstrated a significant change in PPE use before and after protective glasses were provided (Forst et al., 2004; Snipes et al., 2015). Although PPE provision is a strong interventional component in promoting adherence to occupational safety practices, the results of this investigation suggest that providing PPE to workers with low levels of English

Table 2

Descriptive Characteristics by Level of English Language Acculturation

Variable	N	Language Acculturation		p
		Mean (SE) or N (%)		
		Low	Moderate	
Provided PPE				
Baseline	50	3.16 (.20)	4.29 (.19)	0.000
Follow-up	38	4.52 (.12)	4.17 (.18)	0.107
Δ	36	1.14 (.28)	.07 (.21)	0.008
Worker-provided PPE				
Baseline	47	4.51 (.17)	4.35 (.12)	0.532
Follow-up	38	4.32 (.11)	4.33 (.19)	0.947
Δ	35	-.05 (.20)	-.23 (.17)	0.520
Employer-Provided Training				
Yes	26	10 (38.46)	16 (61.54)	0.261
No	20	13 (65.00)	7 (35.00)	0.210
Covariates				
Income	41	1.23 (.12)	1.75 (.18)	0.019
Education	50	2.43 (.18)	3.25 (.22)	0.005
Years working in agriculture	49	11.31 (1.44)	9.54 (1.70)	0.426
Age	49	31.19 (1.29)	32.57 (2.28)	0.592
Sex				
Male	22	9 (40.91)	13 (59.09)	0.412
Female	30	15 (50.00)	15 (50.00)	1.000

language acculturation may increase their use of PPE more than moderately acculturated workers. This finding provides strong evidence of the importance of links between social factors and health. First, linguistic barriers such as limited English language use have been shown to reduce comprehension of occupational safety practices, including the importance of PPE use

Table 3

Association Between Language Acculturation, PPE Provision and PPE Use in ¡Protejase! Intervention

PPE Use at Baseline												
Variable	Provisioned PPE [†]						Non-Provisioned PPE					
	Model 1		Model 2		Model 3		Model 1		Model 2	Model 3		
Employer-provided training	0.86*	(.32)	0.66*	(.30)	0.45	(.33)	0.00	(.25)	-0.02	(.26)	-0.31	(.27)
Low language acculturation			-0.98***	(.28)	-0.95**	(.33)			-0.13	(.25)	-0.00	(.29)
Years working in agriculture					-0.01	(.02)					-0.01	(.02)
Income					0.25	(.21)					0.18	(.20)
Sex					0.02	(.29)					0.21	(.25)
Age					0.02	(.02)					0.03*	(.01)
Education					-0.11	(.14)					-0.02	(.13)
Constant	3.16***	(.22)	3.81***	(.28)	3.41***	(.86)	4.35***	(.19)	4.43***	(.25)	3.18***	(.77)
PPE Use at Follow-Up												
Variable	Provisioned PPE [†]						Non-Provisioned PPE					
	Model 1		Model 2		Model 3		Model 1		Model 2	Model 3		
Employer-provided training	0.01	(.25)	0.06	(.25)	0.26	(.26)	0.37	(.31)	0.34	(.33)	0.33	(.34)
Low language acculturation			0.26	(.27)	0.38	(.33)			-0.13	(.33)	-0.26	(.42)
Years working in agriculture					-0.01	(.02)					0.01	(.03)
Income					0.12	(.19)					0.15	(.24)
Sex					0.25	(.27)					-0.41	(.37)
Age					-0.03	(.02)					-0.01	(.02)
Education					-0.02	(.15)					-0.25	(.20)
Constant	4.36***	(.20)	4.18***	(.28)	4.82***	(.87)	4.13***	(.26)	4.21***	(.36)	5.15***	(1.18)
Δ in PPE Use												
Variable	Provisioned PPE [†]						Non-Provisioned PPE					
	Model 1		Model 2		Model 3		Model 1		Model 2	Model 3		
Employer-provided training	-0.55	(.45)	-0.41	(.44)	0.07	(.45)	0.42	(.28)	0.45	(.26)	0.64	(.29)
Low language acculturation			1.02*	(.42)	1.03*	(.43)			0.26	(.28)	-0.04	(.02)
Years working in agriculture					-0.01	(.03)					0.01	(.02)
Income					-0.22	(.27)					-0.03	(.25)
Sex					0.37	(.39)					-0.29	(.29)
Age					-0.06*	(.02)					-0.03	(.02)
Education					0.11	(.22)					-0.23	(.16)
Constant	1.08**	(.32)	.41	(.43)	1.82	(.90)	-0.37	(.21)	-0.55	(.28)	1.31	(.89)

Note. All values are means with standard errors in parentheses; * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$; [†]Provisioned PPE at baseline reflects pre-intervention usage (before provision)

(Arcury, Estrada, & Quandt, 2010; Arcury, Quandt, Austin, Preisser, & Cabrera, 1999; Arcury, Quandt, Rao, & Russell, 2001). PPE provision may overcome linguistic barriers and ultimately help workers with lower levels of English proficiency increase their use of protection. Some workers with limited English language acculturation may remain vulnerable since they are the least likely to receive PPE from their employers or to understand safety training when it is provided.

Conclusion

Hispanic workers who have low levels of English language acculturation may be most affected by the lack of PPE provision. Most evidence on PPE compliance and use in agricultural settings relates to Hispanic populations, but an understanding of the extent to which language acculturation plays a role in PPE use was not well understood (Forst et al., 2004). Our findings suggest that PPE provision increases the likelihood that farmworkers will use it. Furthermore, providing PPE may increase its use among farmworkers with limited English language use. The strengths of these findings are not without limitations. Our sample size is small, warranting replication of this study using a larger sample. Moreover, our measures of acculturation were limited to language acculturation only. An understanding of how social acculturation relates to pesticide safety behaviors could be important in further understanding links between social factors and the health of farmworkers. Finally, we rely on self-reported behaviors and are not able to confirm the use of PPE use with observational data. These limitations notwithstanding, this research provides valuable insight regarding the role of provision of PPE, and demonstrates that the intersections of provision and language acculturation among Hispanic workers are key factors to increase safety and protection.

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