Safety Climate and Pesticide Risk Communication Disparities in Crop Production by Ethnicity

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Abstract

Pesticide safety is a significant global health concern. This study explored factors associated with the risk divide, a term used to describe disparities in injuries and fatalities between majority and minority workers. Forty (40) farm workers from the South-Atlantic region of the United States were recruited. Results revealed significant differences between ethnic groups on several measured constructs. Latino migrant workers (from the Americas) reported lower perceived control of their work environment and higher risk perception compared to Americans of European descent. Preliminary recommendations relevant to cultural ergonomics, risk communication usability, and safety climate are provided. Implications relevant to farm and manufacturing settings are discussed. © 2010 Wiley Periodicals, Inc.

Keywords: Risk communication; Cultural ergonomics; Pesticide safety; Cultural disparity; Safety climate

1. INTRODUCTION

1.1. Crop Production Systems

Crop production is an agrarian form of manufacturing that was displaced in the last century by the dominance of the industrial age. The similarities between crop and industrial production are fundamental with four major attributes that characterize each work system:

1. The main goal of each work system is to transform raw inputs into outputs the productivity levels of which are based on units released.
2. Both are mechanized, yet still dependent on human labor for specific tasks.
3. Because opportunities have declined in the United States, both industries are now concentrated in rural areas where wages can be capped and unions are difficult to establish, if not banned outright (Fuguitt et al., 1981).
4. Both have been identified by sociologists and economists to consist of structural inequalities (Albrecht, 2004; Kassab & Luloff, 1993). These inequalities have maintained a "production underclass" that conducts production tasks in high-risk contexts and poor safety climates.

One dramatic difference between manufacturing and crop production systems is the number of workplace fatalities. The manufacturing sector has a fatality rate of 2.4 deaths (per 100,000 employed), which is well below the 27.3 deaths (per 100,000 employed) in agriculture. As a single sector, agriculture, forestry, fisheries, and hunting have the highest fatality rates across all industries (U.S. Bureau of Labor Statistics [BLS], 2008). Figure 1 illustrates the industries with the highest fatality rates for 2007.

Although the number of crop production systems (farms) in the United States has decreased, automation has led to an increase in the size of these systems. The decrease was predicted by Beale (1993). Many

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Figure 1 Fatality rates per 100,000 by industry sector (BLS, 2008).

farm workers, especially those who were U.S.-born, moved into other service sectors in response to job losses in crop production. Farm subsidies have also decreased over the past two decades, leaving farmers with minimal net profits. At the same time, new workers, constrained by the degree to which they could participate in legitimate labor markets, moved into the remaining opportunities in crop production. The historical evolution of crop production has, not surprisingly, increasingly involved a labor pool that is faced with limited opportunities to survive financially and that is relatively disenfranchised from other labor markets and job opportunities. Thus, production systems such as farms and food processing must rely on a vulnerable population that will tolerate low wages and high-risk environments—migrant workers and other low-socioeconomic-status ethnic minorities. The economics of this practice are clear—low wages and minimal investments in safe practices are two ways in which crop production systems can maintain net profits, some of which are minimal and can barely sustain the farm owners who manage these systems. Despite the current political climate of lower tolerance for undocumented migrant workers, it is not likely that this practice will cease altogether or even appreciably decrease. This combination of system, economic, and political factors suggests that this population of workers has vulnerabilities that need efforts to focus on prevention and control to minimize or mitigate the risk of exposure to hazardous substances such as pesticides in crop production systems.

1.2. Risk Disparities in Crop Production

Crop production introduces risks of exposure to toxic substances, including pesticides. Chronic exposure to pesticides has been linked to cancer, birth defects, sterility, spontaneous abortion, cognitive and psychomotor deficits, neurological damage that precipitates suicide, and other psychopathologies (Ciesielski, Loomis, Mims, & Auer, 1994; Coye, 1985; Green, 1987, Moses, 1989, Reidy et al., 1992). Both chronic and short-term exposure can lead to death or cause dizziness, headaches, fatigue, and/or acute respiratory problems (Ciesielski et al., 1994).

In the United States, annual pesticide usage rates by farmers exceeds 1.2 billion pounds (544 million kg; U.S. Environmental Protection Agency [U.S. EPA], 2001). There are major challenges, however, in identifying accurate data on exposures. For example, only a few states are required to conduct surveillance of occupational pesticide illnesses, and even in these states smaller farms of 11 employees or fewer are not required to report the data. Another problem is the apparent underestimation of cases. Das, Steege, Beckman, & Harrison (2001) noted the prevalence of inaccuracies in national data, as much of the data accessed through hospital records show only those cases that are diagnosed, and the BLS does not report the statistics. Vulnerable workers, such as migrant workers who have less access to medical care and are less likely to be diagnosed, are not included in the national statistics.

The Pesticide Action Network International (PAN; 2007) addressed the challenges of deriving accurate data on the number of acute and chronic illnesses caused by pesticide exposures, but estimated that, worldwide, 1 million to 41 million people in 2007 were adversely affected by pesticide exposure. Other agencies have attempted to provide periodic and best-estimates from other surveillance data. For example, the U.S. EPA estimates the number of pesticide poisonings to be 20,000 to 40,000 each year. In 2004, poison control centers reported pesticide poisonings across all U.S. states (except Mississippi and North Dakota, which were not included) to range from 1.8 per 100,000 to 5.0 per 100,000 (American Association of Poison Control Centers, 2004).

Within the United States and other countries, pesticide exposure statistics support the presence of a risk divide—in other words, minority cultures experience higher exposure levels and rates compared to majority or dominant cultures (Morello-Frosch & Jesdale, 2006). Ethnic and class minorities within many countries predominantly populate migrant and seasonal work. The National Agricultural Workers Survey, conducted by the U.S. Department of Labor (2005), estimated that 80% of farm workers in the United States were foreign-born, and 95% of these were born in Mexico. Eighty-four percent of farm workers speak Spanish as their first or native language.

In the United States, 85% of farm workers are ethnic minorities, consisting mostly of Latinos followed by African Americans, Haitians, Thais, Jamaicans, and Laotians (National Center for Farmworker Health, 2002). The combination of a high-risk work environment and labor differentiation that mimics social stratification within a culture leads to a higher likelihood of exposure to unsafe working conditions (Perfecto, 1992; Pinderhughes, 1996). Some researchers have focused on training as the major contributor to risk disparities in the workplace. The Worker Protection Standard (WPS) requires all workers who apply, mix, or handle pesticides to receive pesticide training. Training has been shown to be ineffective, culturally incompatible, or non-existent, however (Arcury, Quandt, Austin, Preisser, & Cabrera, 1999; Quandt, Austin, Arcury, Summers, & Saavedra, 1999). In addition, training is only part of the work practice interventions. The EPA, under the WPS, has fined several companies in recent years for violations related to training, risk communications, and decontamination practices. For example, some companies did not train workers, and failed to provide pesticide information or risk communications or decontamination and personal protective equipment (PPE). Companies have also been fined for failure to follow the recommendations on the pesticide labels that require workers to be notified of recent pesticide applications so that they can minimize exposures. Some companies have failed to provide decontamination equipment.

Thus it is important to use effective approaches to prevent or minimize pesticide exposures. Human factors/Ergonomics (HF/E) approaches that include risk assessment, safety evaluation methods, and evaluation of risk communications could support the development of an integrated system of safety management. Beyond the traditional HF/E methods, a sociotechnological approach might also help to address the variances within a system that increase the risk of pesticide illnesses.

Another layer of complexity is introduced when cultural groups develop attitudes about occupational risk that are aligned with their social status within a culture. Unfortunately, the role of culture in occupational safety has not received adequate attention in research. If anything is done at all to address this issue, the basic assumption is that simply translating materials into multiple languages is an adequate solution to cultural usability. Language, however, is only one factor that influences safety training and risk communication effectiveness (Brunette, 2004). Even with some acknowledgement of language needs, some organizations have failed to provide translations that have an acceptable degree of fidelity or consistency in meaning and representations across groups (Triandis, 1995). Despite language challenges, the importance of culture is given relatively little consideration in safety and health. HF/E researchers have repeatedly emphasized the need to give more attention to the systematic examination of cultural influences on system design, training, and injury prevention (Chapanis, 1974; Kaplan, 1995; Smith-Jackson & Wogalter, 2000a,b).

An increasingly visible pattern within the risk literature suggests that several factors correlate with minority status in a variety of risk scenarios. These variables include perceived control over work environment, locus of control (LOC), and self-efficacy (Earle & Cvetkovich, 1997; Grieshop Villanueva, & Stiles, 1994; Karasek & Theorell, 1990; Kouabenan, 1998; Levi, 1990; Lundberg, 1999; Wuebker, 1986). Overall the literature suggests that minority cultures tend to report significantly lower degrees of perceived control over work pace, work periods, and type of work conducted, while also reporting lower levels of participation in workplace decisions. Likewise, minority workers tend to report higher external LOC within work environments—reporting a belief that work outcomes such as accidents and injuries are not prevented by their own behaviors or precautions, but by external others (management, fate, etc.). Minority workers also report lower self-efficacy or confidence in their ability to influence safety-related outcomes in the workplace. Self-efficacy and LOC are important in health belief models used to predict the likelihood that individuals will engage in preventative behaviors (Weinstein, 1993). A lack of control and confidence in one's own opportunities to prevent hazards and a belief that hazards or exposures are controlled by others is a combination of factors that could increase the risk of accidents. Several studies on fundamental differences between ethnic and national cultures have identified values and worldviews that may account for the differences in how workers approach safety and health in the workplace. For example, Hofstede (1980) examined several cultures within organizations and found cultural markers that might influence decision making. One such construct is collectivism, which is described as the extent to which an individual assesses behaviors and actions in relation to the group as a whole or solely as an individual. Although there is great diversity within groups, Latino cultures tend to lean toward a collectivist value system whereas non-Latino North Americans value individualism (Triandis, 1995). The collectivist–individualist continuum is similar to high- and low-context cultures, which are labels coined by Hall (1959). In high-context cultures, strong bonds among people, including family, are highly valued. Compared to European Americans, Latinos show more attributes of high- than low-context culture.

Another workplace-related cultural value that seems predominant in Latino cultures is power distance (Hofstede, 1980; Triandis, 1994, 1997), which is associated with interactions with authority figures and the extent to which vertical organizational structures are valued. Higher power distances are related to less egalitarian views toward authority figures such as bosses, supervisors, managers, or owners. Thus, authority figures are thought of as the primary controllers of work, and their opinions are considered more accurate and less questionable.

Collectivism and power distance could be primary instigators of workplace behavior associated with safety and health associated with ethnic culture. Our research focused on identifying factors that characterize the influence of ethnic culture on safety among farm workers and determining whether reliable differences could be found between ethnic groups on factors that are linked to workplace injuries.

1.3. Methods and Hypotheses

A mixed-methods approach was used to explore the model shown in Figure 2, which illustrates the relationships between culture and other psychosocial variables and their influence on exposure risk. Interest was focused on factors reflecting disparities among cultures and how those differences may interact with variables that influence exposure risk. Variables related to safety climate were measured to determine whether relationships identified in other manufacturing environments were generalizable to crop production systems. Hypothesized was that cultural differences would be present across variables measured. Another goal was to identify preliminary guidelines for the design of culturally competent pesticide safety interventions.

Figure 2 Initial conceptual model.

2. METHOD

2.1. Participants

Forty participants were recruited who self-identified as European American ($n = 17$; mean age [M_{age}] = 44.00, standard deviation [SD] = 10.96) or Latino ($n = 23$; $M_{age} = 35.17$, $SD = 7.95$). The European Americans were all White; the Latinos were from various countries in the Americas, but most were from Mexico. In this study, ethnicity served as the proxy for culture; this is a common approach to classifying individuals on the basis of culture. A number of researchers have identified the strong association between ethnicity (not race) and cultural attributes, because ethnicity involves national and shared history (see Phinney, 1992; Segall, Lonner, & Berry, 1998). Participants were recruited with the assistance of community-based organizations, farm worker outreach organizations, flyers in the general community, and newspaper advertisements throughout several counties in North Carolina and Virginia. Participants were workers on tobacco farms, apple orchards, and cucumber and tree farms in the South Atlantic region of the United States and were roughly equivalent in numbers across each crop category. Latino farm workers reported a mean weekly income of $289.78 USD ($SD = 80.13$) with a mean of 9.42 years of farming experience ($SD = 9.78$) and 8.17 years of education ($SD = 3.39$). European-American farm workers' mean weekly income was $511.56 USD ($SD = 212.23$), 25.59 years of experience, and 13.29 years of education ($SD = 2.95$). Thirty percent of Latino workers reported having received training related to health and safety in crop production, whereas 88% of European-American workers reported receiving training. These differences in participant groups are discussed in later sections of this article.

2.2. Questionnaires

Questionnaires were administered in English and Spanish. There were several parts that were intended to elicit demographic information, use of protective equipment, health symptoms associated with pesticide exposure and safety climate, and awareness of health problems and risk information associated with pesticide exposure. We also used six common warning symbols to test comprehension and nine phrases that could be found on pesticide warning labels. Questionnaire sections asked about different topics and include questions that require open-ended or yes/no responses and Likert ratings. Triandis's (1995) back-translation method to ensure translation fidelity was applied to all questions on the questionnaire. Two bilingual translators worked independently to verify translation fidelity by using the back-translation method to verify equivalence of meaning or interpretation. A primary goal of the overall questionnaire design was to develop a practical, efficient, yet valid measure of the constructs of interest. All of the ratings questionnaires were collectively referred to as "safety climate" measures, because the constructs overlap with safety climate questionnaires developed by Zohar (1980) and Dedobbeleer and Beland (1991).

Seven items from the Risk Perception Scale used by Leonard, Hill, and Karnes, 1989) were administered. Six of the items were revised to apply directly to pesticide hazards (Table 1), and a Likert scale was employed. The five alternatives ranged from *strongly disagree (low rating)* to *strongly agree (high rating)*. This scale was also used in other sections of the questionnaire. Items were:

1. In the past month, I often had thoughts or fears about the health effects of pesticides.
2. Pesticides could affect the health of children born to farm workers.
3. Farm workers will experience health problems in the future that are due to pesticide exposure.
4. I will experience health problems in the future that are due to pesticide exposure.
5. Getting pesticides on my skin can cause an illness that could last a long time.
6. To me, it is more important to work than to worry about getting sick from pesticides.
7. If you are a strong individual, you will not get sick from pesticides. (This item was reverse coded.)

Five items from the Safety Locus of Control questionnaire (Jones & Wuebker, 1993) were used to assess workers' beliefs in the source of control over hazard exposures. The content of the items was modified to be directly relevant to pesticide hazards. Two items measured internal LOC (1, 4), and three items measured external LOC (2, 3, 5). The scale items were:

1. I have a great deal of control over keeping myself from getting sick because of pesticides.
2. I have no control over the amount of pesticides that I am exposed to.
3. There is no point in worrying about being exposed to pesticides. What will be will be.
4. If I become exposed to pesticides and become sick, it is my own fault.
5. Regarding safety from pesticide exposure, I can only do what the supervisor/boss tells me to do.

A Safety Self-Efficacy Scale was developed by the present researchers based on Bandura's (1977) and Mayer and Sutton's (1996) definitions of the construct of self-efficacy. In addition, the content of the items was modified to relate to health and safety information on precautionary behaviors necessary to prevent or control pesticide exposure. Items were also designed to include judgments about common barriers to displaying precautionary behaviors. The seven items were

TABLE 1. Correlation Matrix of Safety Constructs Assessed

Constructs	Risk Perception	Safety LOC (Internal)	Safety LOC (External)	Safety Self-Efficacy	Behavioral Intent
Safety LOC (Internal)	.09	—			
Safety LOC (External)	.20	−.22	—		
Safety Self-Efficacy	.01	.39*	−.30	—	
Behavioral Intent	.32*	.38*	−.06	.38*	—

Note: *Significant at $p < 0.05$.

reviewed for face validity by two independent reviewers who were graduate students with training and education in survey methodology. Each reviewer was given a description of the purpose of the study and the targeted participant cultures, and was provided a definition of self-efficacy from Bandura (1977). The reviewers gave feedback on the relevance of the items to safety and self-efficacy. Iterative modifications were made until the reviewers agreed. Items were:

1. I am confident that I can prevent myself from being exposed to pesticides.
2. I am confident that I can prevent my family from being exposed to pesticides.
3. If I needed advice on how to safely handle a given pesticide, I am confident that I would be able to get that advice.
4. I am confident that I can use personal protective equipment correctly to protect myself when mixing/applying pesticides or when harvesting crops sprayed by pesticides.
5. I am confident that I can stay out of the fields during the restricted entry interval (time period after spraying).
6. I am confident that I can reduce the chance of pesticide exposure by washing my hands before I eat.
7. I am confident that I can use the recommended personal protective equipment in hot weather or when I am tired.

In addition, a scale was administered to participants to examine behavioral intent to display precautionary behaviors. Similar to the development of the Safety Self-Efficacy Scale, the Behavioral Intent items were reviewed by independent judges for face validity. Content was selected on the basis of individual pesticide safety behaviors that can prevent or control pesticide exposure. The eight items were:

1. In the future, I will read the warnings on pesticide labels before using a pesticide.
2. If the label instructions indicate to do so, I will wear gloves the next time I work in fields where pesticides have been sprayed.
3. In the future, I will be careful when handling crops that have been sprayed with pesticides.
4. In the future, I will wash my hands before eating after working in areas where pesticides are used.
5. In the future, I will not enter a field immediately after it has been sprayed with pesticides.
6. I will not go see a doctor the next time I am exposed to pesticides while applying them. (This item was reverse coded.)
7. I will not go see a doctor the next time I become dizzy after working in the fields. (This item was reverse coded.)
8. In the future, I will wash my work clothes after working in areas where pesticides have been used.

Participants also reported whether they personally experienced any symptoms associated with pesticide exposure. They were asked to check any items on the following list that they may have experienced that appeared to be caused by pesticide exposure. The checklist is shown below:

1. — skin rashes
2. — allergic reactions
3. — headache
4. — chest pain
5. — coughing
6. — upset stomach/nausea
7. — vomiting
8. — dizziness/weakness
9. — loss of appetite (not wanting to eat)
10. — problems with memory or thinking
11. — trouble breathing
12. — fainting
13. — itchy eyes
14. — jumpiness, edginess
15. — excessive sweating

The six warning symbols tested are shown in Figure 3. Participants were asked to report the meaning of the symbol if they saw it on a label or brochure.

Several phrases and signal words were selected from pesticide product labels. Participants were asked to report the meaning of the phrases. The phrases were:

- Pesticide drift
- Harmful if absorbed through skin
- Avoid breathing vapor
- Harmful if inhaled
- Get medical attention if irritation persists
- Organophosphate insecticide
- WARNING
- DANGER
- CAUTION

Figure 3 Symbols displayed to participants to test comprehension.

2.3. Procedure

Questionnaires were administered at different sites near farms. Workers were interviewed in locations away from their occupational settings. All documents, including informed consent, were read aloud in English or Spanish unless a worker wished to read and complete the document on his/her own. Spanish was the first language of the Spanish-speaking administrator. Once informed consent was acquired, one copy of the informed consent document with researchers' contact information was provided to participants. Participants were compensated $10 for participation. At the end of the interview, information with EPA and U.S. Occupational Safety and Health Administration (OSHA) hotline numbers as well as pesticide safety brochures were provided to workers. Interviews lasted between 25 and 45 minutes.

3. RESULTS

A Shapiro–Wilk test of normality was conducted on summed ratings of Risk Perception, Safety Self-Efficacy, Internal and External Safety LOC, and Behavioral Intent Scales. All variables showed normal distributions, with W values ranging from .88 to .94.

Internal consistency reliability of the questionnaires was determined by using Cronbach's alpha coefficients. Four of the seven items (2, 3, 4, 5) were retained for the Risk Perception Scale resulting in r_{alpha} of .68. All items of the Safety Self-Efficacy and Behavioral Intent Questionnaires were retained with r_{alphas} of .75 and .63, respectively. Given the small number of items on the Internal Safety LOC (2) and the External Safety LOC (3) questionnaires, no reliability assessments were conducted. As a validity check, we correlated the Risk Perception, Safety LOC, and Safety Self-Efficacy Scales with education and experience to determine whether these two variables might confound cultural differences. None of the correlations were significant. Subsequently, analyses were conducted to test the hypothesis that migrant and seasonal farm workers from ethnic and language minority groups will have lower risk perception of pesticide hazards, higher external LOC, and lower self-efficacy compared to farm workers who are not minority group members.

3.1. Relationships between Safety Climate Variables

Correlations between safety-related variables tested in the hypotheses were conducted using the Pearson coefficient. The results are shown in Table 1. Several variables had significant positive relationships. Significant positive relationships were found between Behavioral Intent and Risk Perception and between Behavioral Intent and Safety Self-Efficacy. These latter two variables were significantly correlated with Internal LOC.

3.2. Cultural Differences in Safety Climate Variables

An independent samples t test was conducted to test the hypothesis of differences between Latinos and European-American farm workers (Folded-F indicated that variances were equal). Figure 4 illustrates the significant differences identified among ratings of Risk Perception [$t(38) = 3.79$, $p < 0.0005$, $d = .54$]; Safety Self-Efficacy [$t(38) = 3.37$, $p < 0.01$, $d = .49$];

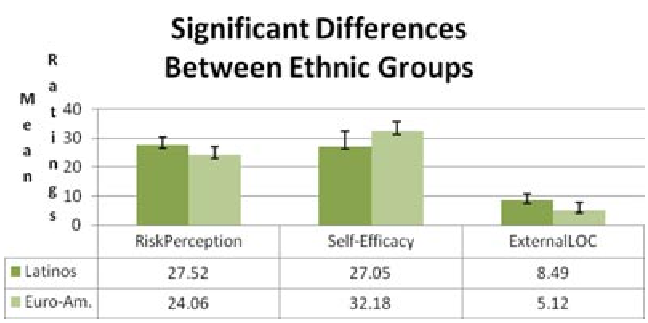

Figure 4 Differences that were significant between ethnic groups.

and Safety External LOC [$t(38) = 4.24$, $p < 0.0001$, $d = .57$]. Behavioral Intent and Safety Internal LOC did not differ between groups and thus are not illustrated in Figure 4. Latino farm workers reported significantly higher Risk Perception and Safety External LOC, and European-American workers reported significantly higher Safety Self-Efficacy.

A validity check was conducted by correlating experience and education with number of reported symptoms. No significant correlations were identified. Differences in total self-reported symptoms were explored to identify any patterns of differences between ethnic groups. An independent groups *t* test revealed that significantly more symptoms [$t(38) = 4.20$, $p < 0.001$, $d = .56$] were reported by Latino farm workers ($M = 7.56$, $SD = 3.23$) than by European-American farm workers ($M = 3.47$, $SD = 2.79$).

Fisher's exact tests were conducted to compare individual symptom reports. Proportionally more Latinos reported experiencing skin rashes, dizziness/weaknesses, nervousness/jumpiness, and loss of appetite compared to European-American workers ($p < 0.05$). Proportionately more European-American farm workers reported experiencing nausea, itchy eyes, and sweating ($p < 0.05$).

Another validity check was conducted to determine the correlation between education and experience and knowledge of symbols and phrases. Significant correlations were identified between education and two symbols—exclamation/hazard alert [$r_{pb}(38) = -.34$, $p < 0.05$] and lightning bolt/electrocution hazard [$r_{pb}(38) = .51$, $p < 0.01$]. Lower levels of education were associated with higher levels of inaccuracy (using point biserial correlation). Fisher's exact tests were also used to explore differences between ethnic groups and knowledge of warning symbols and phrases associated with pesticides. Knowledge was assessed using a variable assignment of correct and incorrect. European-American farm workers gave proportionately more correct responses (88%) compared to Latino farm workers (62%) for the meaning of *pesticide drift*. Pesticide drift is movement of pesticide droplets through air immediately after and following pesticide application (U.S. EPA, 1999). The lightning bolt symbol (Figure 3C) was found to be proportionately different between groups, with European-American workers giving more correct responses (77%) compared with Latino farm workers (46%) ($p < 0.01$). The overall percentages of *accurate* responses for each of the symbols and phrases are shown in Table 2.

TABLE 2. Percent Correct Responses for Definitions of Symbols and Terms Commonly Used on Pesticide Labels

Symbol/Phrase	Latinos	European Americans
Skull/Deadly	93%	100%
Exclamation/Alert	62%	80%
Lightning Bolt/Electrocution*	46%	77%
Yuck/Poison	47%	65%
Prohibition	72%	80%
Asterisk/Alert	47%	65%
Pesticide drift**	62%	88%
Harmful if absorbed	82%	98%
Avoid breathing vapor	90%	98%
Harmful if inhaled	85%	77%
Get medical attention if irritation persists	90%	100%
Organophosphate insecticide	45%	65%
WARNING	70%	85%
DANGER	66%	82%
CAUTION	82%	97%

Note: *Significant at $p < 0.05$; **significant at $p < 0.01$.

3.3. Cultural Differences in Hazard Connotations

Hazard connotations were also elicited by asking participants to rank three signal words (DANGER, WARNING, and CAUTION) from most hazardous to least hazardous. Consistent with other studies, 83% of Latinos and 94% of European Americans ranked the signal word DANGER as the highest in hazard connotation (Figure 5).

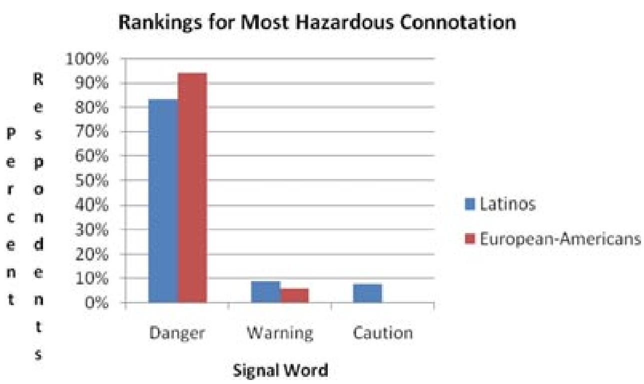

Figure 5 Rankings of "most hazardous" for each signal word by group. Percent values indicate the number of respondents who considered the signal word to convey the most hazardous meaning.

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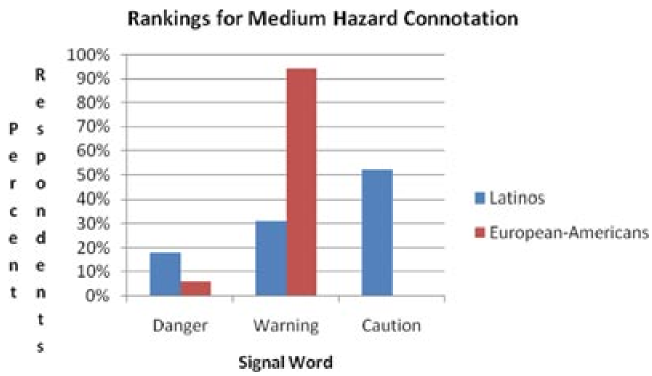

Figure 6 Signal words considered to have an intermediate hazard connotation. Percent values indicate the number of respondents who considered the signal word to convey an intermediate hazardous meaning.

Figure 7 Signal words considered to have the lowest hazard connotation. Percent values indicate the number of respondents who considered the signal word to convey the least hazardous meaning.

WARNING was ranked between DANGER and CAUTION by 94% of European Americans but by only 31% of Latinos (Figure 6). CAUTION was ranked as having the least hazardous connotation by 100% of European Americans and by 43% of Latinos. Fifty-seven percent of Latinos ranked the signal word WARNING with the lowest hazard connotation (Figure 7).

3.4. Barriers to Precautionary Behaviors

Answering the question "What are the reasons why you would not wear protective gear when working with pesticides?" participants reported barriers to wearing PPE. These verbal responses were analyzed using content analysis to identify general themes and patterns. Axial coding was used to identify themes across both groups. A qualitative philosophy was used in which there was no minimum number of responses necessary to assign value to participants' reports. Some themes were common between groups, whereas others were reported by only one group. Two categories of themes emerged that were related to 1) work demands and 2) safety climate. Themes associated with work demands tended to concern fatigue, weather, and time. Safety climate factors were revealed with respect to workers reported having no access to or not wearing PPE when it may be available, even though they use pesticides or work near recently sprayed areas. Table 3 summarizes the themes and frequencies.

4. DISCUSSION AND CONCLUSIONS

The purpose of this research was to understand how ethnic culture influences factors associated with risk of exposure to pesticides. Quantitative results indicated distinct differences in cultural beliefs about safety and the opportunity to engage in and the confidence to use self-protective measures. The results showed that Latino farm workers' beliefs indicated less confidence and fewer opportunities to engage in self-protective behaviors. Likewise, the safety climate indicators reported by Latino farm workers indicated limited access to PPE, the primary control measure to prevent pesticide exposure. Job demands such as thermal stressors (heat) and fatigue were reported by both Latino and European-American farm workers. Because all participants worked with crops that are commonly sprayed with pesticides, and worked in similar environmental conditions, work demands that were considered barriers to PPE should not have been different. Thus, the major differences in terms of exposure risk were in factors that define an organizational environment where one group, Latinos, hold a belief that undermines their ability to prevent exposure. This belief seemed to be present in a perceived safety climate where there is little to no access to measures to protect oneself (i.e., PPE). Figure 8 illustrates the updated conceptual model based upon the results of this study.

The Cronbach's alpha reliabilities fell below the acceptable level, which is based on Nunnally (1978). The levels, however, are not substantially less than the .70 values, given the number of items on each scale. Lower numbers of questionnaire items are associated with lower Cronbach values, whereas questionnaires with larger numbers of items might very well have an inflated alpha value (Rodriguez & Maeda, 2006). Thus, the Risk Perception Scale reliabilities of

TABLE 3. Frequencies of Reported Barriers to the Use of PPE

Category	Not Wearing PPE (Reasons)	Latinos	European Americans
Work Demands/Hazards			
	Weather, too hot to wear	8	9
	Too tired to put it on	2	0
	Don't wear it if task is fast or takes little time	0	2
Workplace Practices			
	PPE was not given to me	8	0
	No one else on the farm wears PPE	2	0
	Can't afford PPE	2	0
	Not necessary to wear PPE	2	2
	Not required to wear PPE	1	0
Total Barriers		25	13

Note: *Themes with a frequency of 0 were not reported by the respective ethnic group.

.68 with only 7 questionnaire items and .63 for the Behavioral Intent Questionnaire with only 8 items do not undermine the effectiveness of the questionnaires in terms of supporting inferences. Given the authors' past experience, lengthy questionnaires completed by less educated and less literate participants tend to show lower reliability and validity. The quantitative data revealed that Behavioral Intent to display precautionary behaviors was significant and positively correlated with Risk Perception, Safety Internal LOC, and Safety Self-Efficacy. Higher Risk Perception and Internal LOC were associated with higher ratings of Behavioral Intent to display precautionary behaviors, and this finding is similar to those by Arcury, Quandt, and Russell (2002) for exposure to pesticides. Higher Safety Self-Efficacy was also associated with higher Behavioral Intent ratings. These results validate those of previous studies that focused on disparities in other occupational settings among minority and majority group members (Earle & Cvetkovich, 1997; Grieshop et al., 1996; Karasek & Theorell, 1990; Kouabenan, 1998; Levi, 1990; Lundberg, 1999; Wuebker, 1986). Significant differences in ratings were found among ethnic groups among these factors. Latino farm workers reported higher Risk Perception ratings compared to European-American farm workers. A study by Arcury and colleagues (2002) identified a strong positive relationship between pesticide knowledge and perceived risk of pesticides. Because lack of awareness is associated with lower risk perception, the investigators implicitly assumed that Latino farm workers' lower levels of knowledge (due to lack of access to relevant information) would lead to lower risk perceptions. Studies by Finucane, Slovic, Mertz, Flynn, and Satterfield (2000), however, indicate a tendency of younger white men (compared with women and other ethnic groups) to report relatively lower perceptions of risks for many different hazards. Although the mean age of European-American farm workers in this sample was greater than that of the Latino participants, some of the same effects may be happening here in terms of differences in risk perceptions. Latino workers may be more aware of their lack of knowledge associated with pesticides possibly because virtually all labeled warning communications about pesticides are in English, a language that Latino migrants often do not know as well.

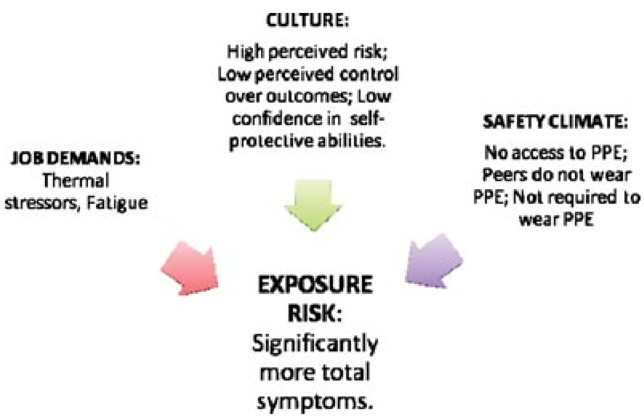

Figure 8 Updated conceptual model with quantitative and qualitative results specific to Latino workers.

As expected, Latino workers reported lower confidence in their ability to protect themselves from pesticide exposure in the workplace. This lower self-efficacy could be related to the power dynamics within the workplace settings and the status of Latino workers, which might increase the chances that they are not provided with necessary personal protective technologies or information. Likewise, Latinos reported a higher external LOC, which supports the interpretation that Latinos attribute control over safety-related outcomes to external others (bosses, supervisors, fate), which also indicates a lower intent to engage in self-protective behaviors. Given the combination of low self-efficacy, high risk perception, and lower external LOC, an inference could be made that a number of dynamics associated with social status that occur among cultures are replicated in occupational settings and safety climates. Latino farm workers reported a higher awareness of the dangers of their work, but in the face of higher risk perception reported less control and less confidence in their ability to protect themselves. This pattern could represent the consequences of social dynamics within the workplace that stratify workers by ethnicity.

In addition to the differences in important psychosocial variables, Latino workers reported significantly more total symptoms associated with pesticide poisoning. The lack of awareness of symbols and phrases did not differ to a great extent between ethnic groups. With the exception of the LIGHTENING BOLT and the *pesticide drift* phrase, no other significant differences were found. The pattern of these two differences was within the predicted direction with European-Americans reporting significantly more correct responses. It is interesting that, even though there were no significant differences between groups, there were several symbols and phrases that indicated a disturbing lack of knowledge among members of both groups. For example, only 47% of Latinos and 65% of European-American farm workers gave correct answers for the yuck and asterisk/alert symbols. Also, only 45% of Latinos and 65% of European Americans comprehended the phrase "organophosphate insecticide," a technical term that should be elaborated upon or redundantly phrased using a simpler term when used in risk communications on product labels.

The hazard connotations assigned to signal words differed between groups. Based on The American National Standards Institute (ANSI) Z535 standard, signal words are ordered by hazard connotation as DANGER, WARNING, and CAUTION. There was general agreement with assigning the highest hazard connotation to DANGER, but 57% of Latinos ranked WARNING as having the lowest hazard connotation (lower than CAUTION). Although no statistical tests were performed, the general pattern of rankings for European Americans matched the ANSI order: DANGER, WARNING, and CAUTION. Based on the majority of responses from Latinos, the data indicated an order of DANGER, CAUTION, and WARNING. This result could indicate differences in mental representations between cultural groups, but further investigation is required.

4.1. Recommendations

This study identified factors that differentiated Latino farm workers from other groups. In comparison with European-American farm workers, these differences included:

1. Lower confidence in ability to protect themselves from pesticide exposure;
2. Higher perceptions of the dangers of pesticides;
3. Beliefs that safety or risk of exposure is controlled by powerful others (e.g., supervisors);
4. Beliefs that they have no or limited access to protective equipment;
5. Different interpretations of the connotative meaning of certain signal words commonly found on pesticide labels and in pesticide educational materials; and
6. Higher numbers of reported symptoms related to pesticide exposure.

These outcomes can be used as requirements to design culturally competent interventions within a cultural usability approach.

As yet, there is no organized methodology to support valid and reliable evaluations of cultural usability. A number of considerations are evident from this study, however.

Cultural usability applied to risk communication design needs more emphasis in the following areas:

- The differences between groups relevant to language and the cognitive representations communicated by language;
- Factors that relate to the context of use for different cultural groups, some of which may involve high power distances and social stratification;

- Specific cultural attributes that may account for varying beliefs and expectations among groups—in other words, this research and Hofstede's constructs (1997);
- Identification of relatively universal symbols and signal words;
- Testing within the context of use; and
- Inclusion of cultural groups through the use of participatory design.

Although differences are important as a research focus, the search for risk communications and behavioral interventions that are generalizable across all ethnic cultures should also be a goal. Previous work by Smith-Jackson, Essuman-Johnson, and Leonard (2003) examined symbol primes as basic sets of symbols that could be generalized across cultures. Basic geon/symbol parts indicating "to do" and "not to do/prohibition" were generally well understood by Ghanaian and American industry and trade workers. Previous studies by Smith-Jackson and Wogalter (2000a,b) also showed some agreement in the hazard connotations associated with the color red between two Latino and non-Latino participants. The *Globally Harmonized System for Classification and Labelling of Chemicals* is an attempt by the U.S. EPA to identify a universal set of symbols, but extensive testing in a variety of global contexts has not been conducted. Because testing in various contexts is the only way to identify symbols that will be usable across cultures, efforts thus far have questionable validity. Warnings and risk communications are part of a larger system and organizational context and cannot replace other prevention and control measures such as designing out or guarding against exposures. The findings in this study may also generalize to industrial manufacturing settings. In particular, the effectiveness of risk communications used to convey chemical hazards in machine or processing operations can be undermined by safety climate and barriers experienced by workers.

4.2. Limitations

This field study was designed to explore specific variables that might account for disparities in health and safety in crop production. The study was exploratory and used relatively small sample sizes. For the quantitative analyses, the sample sizes for each group resulted in moderate effect sizes as reported through the Cohen's *d* values. Moderate effect sizes are of interest to future research because they provide useful information for the types of measures and classifications that would support further research with larger sample sizes as well as determining whether scales should be improved or replaced with more sensitive measures.

The coefficient alpha reliabilities for the Risk Perception Scale and the Behavioral Intent Scale were .68 and .63, respectively, and did not achieve the standard often referenced in questionnaire reliability studies (.70; Nunnally, 1978). As noted by Streiner and Norman (1989) and Rodriguez and Maeda (2006), reliabilities of questionnaires with a small number of items tend to be lower due to artifacts of reliability estimation equations. Only four items were retained on the Risk Perception Scale, and eight were retained on the Behavioral Intent Questionnaire. The intention was to keep the number of items in the questionnaires to a manageable set, because an unduly long questionnaire would have undermined participation or completion of the questionnaire. Given the value placed on the external validity of this research, reliabilities of .68 and .63 are not substantially less than the guideline criterion level of .70. Furthermore, these levels were achieved despite the questionnaire being administered in a variety of contexts and environments with participants completing the items under stress (taking time away from work and any belief that there may be a potential backlash from owners/supervisors).

It is important to note that, although experience and education did not influence the results reported (with the exception of two of the symbols), disparities in training could have been influential. Only 30% of Latino workers reported receiving any training on issues related to health and safety in crop production. Eighty-eight percent of European-American workers reported receiving training. The degree of training, however, may be influenced by specific differences between in-groups and out-groups and the transient nature of migrant workers, most of whom were Latino. This influence could not be factored in or out of the analyses, but future studies could explore its potential impact.

There were a number of additional items (such as legal status) that could have been added to explore the influence of participants' backgrounds. Delving into the backgrounds of migrant workers, however, may very well undermine trust and decrease the number of workers who agree to participate. In addition, ethical guidelines do not allow researchers to ask information regarding status because this knowledge may make workers more vulnerable to consequences resulting from immigration and naturalization laws. Field research in disciplines such as public health and criminal justice is influenced by trade-offs between the desire to acquire useful data and the demands related to ethically protecting the confidentiality and status of participants. Thus this research was also challenged by these demands.

4.3. Future Studies

We are exploring ways to translate results into meaningful interventions related to the design of educational materials and field interventions. The goal is to use culturally competent usability approaches to test how risk communications and behavioral interventions in context impact the risk of exposure to pesticides.

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