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Observed and Self-Reported Pesticide Protective Behaviors of Latino Migrant and Seasonal Farmworkers

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Abstract

Agricultural pesticide exposure has potential adverse health effects for farmworkers that may be reduced by pesticide protective behaviors (PPBs). The Environmental Protection Agency's (EPA) Worker Protection Standard (WPS) requires PPBs be taught to farmworkers prior to field work. Studies to date have not utilized observational methods to evaluate the degree to which PPBs are practiced by Latino migrant and seasonal farmworkers in the United States. The purpose of this study was to describe, compare, and contrast observed and self-reported PPBs used by Latino farmworkers; both PPBs that the WPS requires be taught and other PPBs were included. Observed and self-reported data were collected from 71 Latino farmworkers during the 2014 tobacco growing season in North Carolina. Participants were consistent in reporting and using long pants and closed shoes in the field most of the time. In addition, gloves, hats/bandanas, and water-resistant outerwear were frequently observed, although they are not required to be taught by the WPS. Farmworkers reported more long-sleeve ($p = .028$) and glove use ($p = .000$) than what was observed. It was uncommon to observe washing behavior before eating or drinking, even when washing supplies were available. Washing behaviors were significantly overreported for hand ($p = .000$; ($p = .000$) and face ($p = .000$; ($p = .058$) washing before eating and drinking in the field. This study documents that protective clothing behaviors that the WPS requires be taught, plus a few others are commonly practiced by Latino migrant and seasonal farmworkers, but washing behaviors in the field are not. Targeted strategies to improve washing behaviors in the field are needed.

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Keywords

agricultural pesticides; protective behaviors; observational method; Latino migrant and seasonal farmworkers

Introduction

Exposure to agricultural pesticides may be linked to long-term deleterious health consequences for farmworkers including cancer, neurological disorders, reproductive health problems and infertility (Mills, Dodge & Yang, 2009; Savage, Keefe, Mounce, Heaton, Lewis & Burcar, 1988; Furlong et al, 2015; Arbuckle, Lin & Mery, 2001; Lacasaña, Vázquez-Grameix, Borja-Aburto, Blanco-Muñoz, Romieu, Aguilar-Garduño & García, 2006; Gilden, Huffling & Sattler, 2010)). While farmworkers may not directly apply pesticides, they can be exposed through the skin or eyes (dermal); through eating, drinking, and other hand-to-mouth behaviors (ingestion); and through breathing vapors and dusts (inhalation). Farmworkers come in contact with pesticide residues during regular crop maintenance and harvesting, as well as through drift from nearby fields or the unintentional treatment of the area where they are working (Mobed, Gold, & Schenker, 1992).

Use of pesticide protective behaviors (PPB) especially those mandated to be taught by the WPS such as wearing long-sleeved shirts, long pants, socks and closed shoes, clean work clothes, handwashing with soap may reduce exposure to agricultural pesticides and potentially minimizes adverse health outcomes (Curwin, Hein, Sanderson, Nishioka & Buhler, 2003; Fenske, Blacker, Hamburger & Simon, 1990; Hernandez-Valero, Bondy, Spitz & Zahm 2001; Salvatore et al., 2008). The Worker Protection Standard (WPS), first published in 1974 by the Environmental Protection Agency (EPA) applied to those performing hand labor after pesticide applications. The requirements were simply not spraying people, a general reentry period for 12 pesticides, a requirement for protective clothing for early reentry and a requirement for “appropriate and timely” warnings. Recognizing that these were inadequate, a series of public meetings in 1988 led to the Worker Protection Standard of 1992 which addressed both those who handled pesticides as well as those who performed tasks related to cultivation and harvesting. It required that agricultural pesticide users and employers of agricultural workers provide to themselves and others information about exposure to pesticides, protection against exposure and ways to mitigate exposure. Information by way of pesticide safety training within 5 days of beginning work in a field and every 5 years thereafter, and instructions on how to mitigate exposure and access to labeling information were required. Protection included excluding workers from areas being treated, maintaining restricted-entry intervals (REIs) and notifying workers about treated areas. Mitigation included decontamination sites including water, soap and towels for routine and emergency decontamination and emergency assistance. After recognition that these were still inadequate, a series of public meetings in 2013–2014 led to the 2015 revisions. Among other revisions, training about required protections is now mandated annually and with no grace period of 5 days and records of the training must be kept by the employer for 2 years. Furthermore, at least 1 gallon of water per worker must be supplied for decontamination. The Worker Protection Standard has informational

requirements as well as structural requirements, e.g. with regard to supply provision. The field sanitation standard in North Carolina administered by the NC Department of Labor also has certain structural mandates which include the provision of water and soap for washing within ¼ mile of where the worker is working.

Previous studies have not utilized field observational techniques to evaluate the degree to which PPBs are practiced by Latino migrant and seasonal farmworkers in the United States. The actual level of PPB adherence must be understood in order to understand the link between exposure, behavior and possible health effects which may impact health policy and protection standards, educational requirements, and interventions that decrease pesticide exposure.

Protective behaviors are defined as ways farmworkers can reduce their exposure to pesticides (Strong, Thompson, Koepsell, & Meischke, 2008). According to the EPA, these behaviors include washing hands before eating, smoking, or using the restroom; wearing protective clothing to minimize skin contact with residue at work (such as long-sleeved shirts, long pants, and work boots); showering and changing clothes immediately after work; and washing work clothes separately from other laundry and per the WPS, these behaviors are required to be taught to farmworkers as part of the informational component of the WPS. While not required to be taught, gloves have been reported to be efficacious in minimizing pesticide exposures (California Poison Control System, 2013; Furlong et al., 2015; Hernandez-Valero et al., 2001; Quandt et al., 2006; Salvatore et al., 2008);substituting hand sanitizer for handwashing in the field may exacerbate insecticide exposure risk (Coronado, 2012).

Studies of self-reported farmworker behaviors have found that many do not use pesticide protective equipment (PPE), one facet of PPB. In a study that included 270 Hispanic farmworkers recruited in an eight-county area of North Carolina in which tobacco and cucumbers were the primary crops, farmworkers were queried about whether they used any methods to protect against pesticide exposure; 22% said they always used a method to protect against exposure and 53% said they never did (Arcury, Quandt, Austin, Preisser, & Cabrera, 1999). As recently as 2012, more than 25% of Hispanic farmworkers in another study in North Carolina in which tobacco was the primary crop did not report using PPE (Levesque, Arif, & Shen, 2012b). Use of PPE was defined for that study as wearing gloves, socks, and a hat or cap while performing fieldwork; however, none of those behaviors, with the exception of wearing socks, is required to be taught by the EPA. Specifically, 33% of the farmworkers did not wear a hat/cap or socks, and 25% did not wear gloves while working in the fields within the previous month. All of the farmworkers in the sample reported receiving training about how to prevent or reduce pesticide exposure in the workplace. Based on these self-report studies, use of PPE, a facet of PPB, is inadequate, but no studies to date have examined these with an observational method.

The purpose of this study was to describe, compare, and contrast the observed and self-reported PPBs used by Latino migrant and seasonal farmworkers as required to be taught in the EPA's WPS. We also observed and queried farmworkers about their use of gloves and hand sanitizer, and observed their use of hats and water-resistant outerwear, none of which

are required to be taught by the WPS. To achieve this goal we collected observed and self-reported data from 71 Latino farmworkers in North Carolina.

Materials and Methods

Participants

One of the three largest North Carolina counties for tobacco production was selected as the location for recruitment. Growers were chosen based on access; seven growers in that county had previously participated in a safety intervention called Certified Safe Farms (CSF) (North Carolina Agromedicine Institute, 2012), which focused on injury reduction. Three out of the seven growers who participated in CSF agreed to allow access to their farms for recruitment of farmworkers. Seventy-two farmworkers were approached on the three farms, and all voluntarily participated in the study. Institutional review board approval and informed consent were obtained.

Inclusion criteria consisted of the following characteristics: age 18 or older, ability to speak Spanish or English, and self-identification as being of Latino ethnicity. One farmworker in a supervisory role did not participate in the observational portion of the study because his work tasks were substantially different, leaving observed data from 71 participants for comparison. All data were collected between May and October 2014.

Variation existed among the farms enrolled. The first two farms were smaller than the third in terms of acreage and the number of farmworkers employed (5, 7, and 60, respectively). Because data were collected by the primary investigator sequentially, there was also variation in work task being performed at the time of observation. In the process of cultivating tobacco, the seed is grown before being transplanted to the field; the field is maintained through weeding; the more mature plant is topped and suckered (removal of the tobacco flower); and then the leaves are harvested and barned to be cured. Perceived and actual exposure may vary some based on work task, but PPBs are encouraged with all activities. During observation, workers on the first farm were weeding shortly after the tobacco transplantation; on the second farm, workers were topping and suckering prior to harvest; and on the third farm, workers were harvesting and barning leaves, as well as topping and suckering.

Measures

Participant Characteristics—Investigator developed questions about participant characteristics (21 items) included demographics (e.g., age, gender, and ethnicity), agricultural experience, worker status (whether or not the farmworker was in the United States on a work visa), education, English proficiency, pesticide training, and cancer in the farmworkers' families.

Observed Pesticide Protective Behaviors—The investigators developed a quantitative observational checklist to record the PPBs of farmworkers. This instrument provided a way to carry out naturalistic, nonparticipant observation in which the setting, events, and behaviors were naturally occurring (Price & Oswald, 2006). The behaviors included in the observational checklist were identified from the EPA "Protect Yourself from

Pesticides" brochure developed to address WPS criteria (United States Environmental Protection Agency [U.S. EPA], 2006).

Of the behaviors required to be taught, eight were observable: wearing long pants, wearing a long-sleeved shirt, wearing shoes, wearing socks, washing hands before eating, washing hands before drinking, washing face before eating, and washing face before drinking. Several additional behaviors were self-reported but were not observable (e.g., bathroom and showering behaviors). Glove use, the use of water-resistant outerwear and the use of hats, while not required to be taught, were also captured. In every 30 minute block on the checklist, the primary investigator noted a yes, no or could not be observed for each behavior by each participant.

Self-Reported Pesticide Protective Behaviors—The self-report of behavior questionnaire t was created by the investigators based on the WPS, inquiring about the eight behaviors described above (plus glove use) and adding 12 nonobservable behaviors. These additional behaviors included washing hands and face before smoking, chewing gum, or chewing tobacco; washing hands before using the toilet; staying out of areas where pesticides are applied; keeping out of restricted areas; keeping out of areas "the boss tells you not to go in"; never taking pesticides or empty pesticide containers home; keeping children away from pesticides; washing one's whole body, including hair, after work each day; and keeping dirty work clothes separate from nonwork clothes and family laundry. Additionally, two questions were included about the use of hand sanitizer. As PPBs may vary throughout any given day and over the course of a season), behaviors that always occur were not possible to assess, so questionnaire items asked if farmworkers normally carried out the behaviors, with the response options "yes," "no," or "sometimes."

Procedures

Data Collection—Each enrolled grower consented to allowing the primary investigator to approach employed farmworkers for participation during work hours, be on their property for observations, and collect data with the study team. On the day of observation, the primary investigator recruited and verbally consented no more than 8 workers, as this was the maximum number of workers feasible for observation (based on a pilot study). Those who consented to participate were given a study identification number on an index card (a field-tested procedure from the pilot study) to enable pairing of the observational and self-reported data.

The observation period included the entirety of the workday, which ranged in length from 6 to 12.5 hours based on the amount of work to be done and the weather. Observations were recorded for each participant every 30 minutes. Each behavior was recorded every 30 minutes either as being done, not being done, or not able to be observed. The checklist utilized an event tally system—a way to sample all occurrences of some behaviors (Altmann, 1974). The majority of the clothing behaviors were clearly operationalized ; the person did or did not wear closed shoes, socks, long pants, a long sleeved shirt, gloves, a hat or water-resistant outerwear in those 30 minutes. Washing was operationalized as vigorous, brief rubbing together of all surfaces of premoistened lathered (with or without soap for the

purposes of the study) hands and fingers followed by rinsing under a stream of water (Centers for Disease Control and Prevention [CDC], 2009; see also CDC, 2013). The same operationalization was utilized for face washing. Notes were made if hand sanitizer was used in place of soap. An assessment of washing supplies available was recorded for each 30-minute time period via field notes. There were a total of 1,442 observations made.

Self-reported data were collected on a subsequent weekend evening at the workers' homes or labor camp. Verbal administration of the Self-Report of Behavior Questionnaire was chosen because the interview method is recommended over pencil-and-paper self-report when a large proportion of the population has limited literacy skills (Waltz, Strickland, & Lenz, 2010). Two independent Spanish translations of the Self-Report of Behavior Questionnaire were completed, and the versions compared. A pilot with two farmworkers not in the study was conducted to facilitate item refinement. A native Spanish speaker whose parents were farmworkers and who grew up close to the farms in the study was trained to administer the Self-Report of Behavior Questionnaire and collect demographic data with the primary investigator present. All participants responded in Spanish.

Extensive field notes helped to triangulate findings between observed and self-reported behaviors, including availability of hand washing supplies (Stake, 1995). To compensate for their time, farmworkers received a $25 Walmart gift card and a hat from a local farmworker service agency after completing both the observation and self-report components.

Quality Assurance—All data were managed using REDCap electronic data capture tools (Harris et al., 2009). For quality assurance purposes, 10% of the data were reviewed by the primary investigator for accuracy, with 100% accuracy found. Self-reported questionnaire data were recorded by the interviewer on paper as well as audio recorded for quality assurance.

Data Analysis—Data were analyzed in SPSS v22 (IBM Corporation, 2013). Descriptive statistics, including frequencies, were run for all of the demographic variables. Observed behaviors were aggregated from an individual observation level (a 30-minute time period) to a person level, and then placed into one of three categories: none of the time (0% of the observations), all of time (100% of the observations), or some or most of the time (operationalized as >0% and <100% of the observations), and descriptive statistics were run. The investigators chose to combine some of the time with most of the time, so that response options would mirror what was self-reported. In retrospect, four categories to allow for both some of the time and most of the time for both the observed and self-reported data would have afforded richer data. Descriptive statistics were run on the responses to the Self-Report of Behavior Questionnaire, which were categorized as no, yes, and sometimes. Finally, Wilcoxon signed rank tests were used to compare observed behaviors (at a categorical level) with self-reported behaviors. A p value of .05 was used to determine statistically significant differences.

Results

Participant Characteristics

In this study, participating farmworkers were predominantly males (96%) from Mexico (97%) with an average age of 33 years (range 18–68); most completed no more than a middle-school education (89%). The majority (90%) were in the United States on a work contract and had worked an average of 12 years in agriculture outside of the United States and 6 years in the United States. Almost all reported some pesticide safety training experience (97%) and that training had occurred within then EPA-regulated timeframes of 2012 or later (97%). These and other characteristics can be found in Table 1.

Observed Behaviors

Of the nine observable behaviors, wearing long pants (n = 70, 98.5%), closed shoes (n = 65, 91%), and long sleeves (n = 64, 90%) were most often observed by the 71 participants (see Table 2). One participant rolled up his pants for a portion of the observation, and a second had a tear in the knee of his pants. While wearing closed shoes was common, some of the shoes worn were not protective; 21% (n = 15) wore porous shoes (fabric shoes with or without laces) and 4% (n = 3) were not closed at all (sandals, flip-flops, or a sock alone, which counted as a not closed shoe). Protective shoes, worn by 86% (n = 61) of farmworkers, included leather shoes, heavy sneakers with laces, rubber boots, or other work boots. Participants who wore closed shoes for only some of the time (8%) often started the workday in boots and changed at a morning break or lunch into a sandal or flip-flop.

Only 13 participants were dressed so that sock use could be evaluated; the majority of those participants wore socks (85%, n = 11). One participant worked in short sleeves all day, and of the 8% who wore long sleeves during only some of the observation period, one wore a short-sleeved shirt with gloves over his elbows, which was described as being more protective than a long-sleeved shirt. Several participants were observed wearing two shirts (protective), and several others worked with buttons undone at the neck and wrists (increasing their exposure risk).

The vast majority of participants (93%) wore hats all of the time. A baseball cap was far more commonly worn (72%, n = 51) than a wide-brimmed hat (15%, n = 11), and some (13%, n = 9) participants changed from one to the other during the day (e.g., from a wide-brimmed hat to a baseball cap). Forty-one percent (n = 34) of farmworkers wore a bandana at some time under either kind of hats and/or over their ears.

Gloves were worn less consistently, with 39% (n = 28) wearing them all of the time and 41% (n = 29) wearing them some of the time. The times during which gloves were never worn, workers were operating controls (n = 1), leading the team (n = 1), topping (n = 3), weeding (n = 5), or driving tractors (n = 5). The type of glove used and glove re-use were not captured. Also of interest, the majority of participants wore water-resistant outerwear at least some of the time, and usually in the morning hours when there was more dew on the tobacco leaves (65%, n = 48). Most of the participants (90%, n = 43) who used water-resistant outerwear removed it before 11:00 a.m.; 4 (8%) participants tied it around their waists until the lunch break and 1 participant left his tied around his waist until the end of the workday.

Washing behaviors before eating were difficult to observe. Most lunches were unobserved because lunch occurred in participant housing (which the investigator did not enter), in an open shed for workers near where the tobacco was stored, or spread through the field if lunches were brought in by truck. The eating that was typically observed was a morning or afternoon snack. For the 41 participants (58%) for whom observation of an eating opportunity was possible, only 17% ($n = 7$) washed their hands before eating, and none were observed washing their face before eating. Each participant may have engaged in eating once, more than once or not at all.

Availability of washing facilities and supplies are also important in this context. Washing facilities on each of the farms consisted of sinks or large water drums with spouts and soap on trailers beside portable toilet facilities. Two farms consistently had these facilities with soap and water available for the entirety of the workday. The primary investigator did not measure the distance from where the washing facilities were placed and the workers at each point of the day. The field sanitation standard mandates that the facilities be within ¼ mile of the workers at all times (North Carolina Department of Labor, 2005). Likewise, the primary investigator did not measure the temperature of the water over the course of the day. While some literature suggests that Latino farmworkers are less likely to wash their hands in cold water after physical activity for fear of arthritis (Salvatore et al, 2008; Arcury, Quandt, Cravey, Elmore & Russell, 2001; Quandt, Arcury, Austin & Cabrera, 2001), the primary investigator did not take the temperature of handwashing water. As a user of the same facilities, she did however note that the water in the large drums seemed cooler in the morning and warmer in the afternoons as the heat of the day impacted the containers.

There was one farm for which the provision of supplies for washing varied over the course of the day (either the facilities did not make it into the field or they were brought without soap). In 67% of the 30 observed opportunities to wash hands before eating, adequate supplies (soap and water) were available, while in the remainder, inadequate supplies (water alone or nothing) were available. In 67% of the 29 observed opportunities to wash the face before eating, adequate supplies were provided. In the case of soap and water being available, 35% of participants used those supplies.

As described above for use of water-resistant outerwear and some protective clothing, behaviors varied based on the time of day. Clothing behaviors (specifically the wearing of closed shoes, long sleeves and gloves) worsened over the day, as did washing hands before drinking, while washing hands before eating seemed to improve over the course of the day (see Table 3). On the one farm where there was variation in provision of supplies, the time when inadequate washing supplies could be observed most often was between 11:00 a.m. and 3:00 p.m. (In 41/65 observations where data was available (63%), washing supplies were inadequate).

While observing drinking during the lunch meal was difficult, drinking was frequently observed in the field. In 80% ($n = 89$) of the 111 observed opportunities to wash hands before drinking, soap and water were available. Despite supply availability, 87% of the 69 participants who were observed drinking did not wash their hands any of the time before drinking. Additionally, 34 participants (49%) drank while wearing at least one glove. One

participant was observed wiping her hands in the dirt of the field twice before drinking when hand washing supplies were available. Not a single participant washed his/her face before drinking. Seven (10%) participants were observed spitting before drinking (either rinsing their mouth with the first sip of water, or spitting their own saliva) as a form of washing out the mouth before drinking. Use of hand sanitizer was never observed.

Self-Reported Behaviors

In the self-report questionnaire, participants most commonly reported wearing long pants (100%, $n = 71$), socks (98.5%, $n = 70$), long-sleeved shirts 97% ($n = 69$), closed shoes (93%, $n = 66$), and gloves (83%, $n = 59$; see Table 4). With regard to washing behaviors in the field, the majority said they normally washed their hands (91%, $n = 65$) and face (63%, $n = 46$) with soap and water before eating. The majority also said they normally washed their hands (58%, $n = 41$) and face (44%, $n = 31$) with soap and water before drinking. Fewer participants reported the regular use of hand sanitizer before eating (27%, $n = 19$) and drinking (41%, $n = 29$).

Participants reported high levels of other washing behaviors that were not a part of the field observation. The overwhelming majority said they normally washed their whole body, including hair, after work (98.5%, $n = 70$); changed their clothes after work (98.5%, $n = 70$); and washed their work clothes separately from nonwork clothing (98.5%, $n = 70$). Slightly fewer reported normally showering after direct contact with a pesticide (87.5%, $n = 62$) and washing their hands before using the bathroom (80%, $n = 57$). Fewer still reported normally washing their hands or face before smoking, chewing tobacco, or chewing gum (56%, $n = 34$), with 10 participants stating that they did not engage in tobacco use or gum chewing behavior. Very few participants reported they normally re-wore work clothes without washing them (6%, $n = 4$).

All participants reported normally staying out of areas the boss told them not to enter (100%, $n = 71$), and few said they normally entered restricted areas in the field (6%, $n = 4$). The vast majority normally kept children away from pesticides (98.5%, $n = 70$), with 6 participants noting the lack of children on the farm. No participants reported taking pesticides or empty pesticide containers home with them.

Comparison of Observed and Self-Reported Behaviors

Observed and self-reported behaviors of wearing closed shoes, long pants, and socks were consistent and highly utilized, with no statistical differences existing (see Table 5). Self-reported long-sleeve use ($z = 2.20$, $p = .028$) and glove use ($z = 4.99$, $p = <0.001$) were significantly higher than observed. Observed washing behaviors in the field did not mirror self-reported washing behaviors. Self-reported hand washing ($z = 4.06$, $p = <0.001$) and face washing ($z = 1.90$, $p = .058$) before drinking were higher than observed. Washing before eating was even more strikingly discordant with both self-reported hand washing ($z = 4.77$, $p = <0.001$) and face washing ($z = 4.54$, $p = <0.001$) higher than observed.

Discussion

The farmworkers who participated in this study may have had a higher than average safety orientation. They reported high average years of experience and being in the United States on an H2A visa, each of which is associated with safer working conditions (Whalley et al., 2009), and the farms where the workers were employed were motivated toward safety, as evidenced by their participation in the Certified Safe Farms intervention (North Carolina Agromedicine Institute, 2012). Despite this safety orientation, the observed farmworker engagement in PPBs required to be taught by the WPS was inadequate in the area of washing. While farmworkers reported high adoption of washing behaviors prior to eating and drinking, observed behaviors were much less. This suggests possible limitations of some previous studies on farmworker behaviors that relied solely on self-report data (Arcury et al., 1999; Ciesielski, Loomis, Mims, & Auer, 1994; Hernandez-Valero et al., 2001; Levesque, Arif, & Shen, 2012a; Levesque et al., 2012b; Salvatore et al., 2008).

Another advantage of an observational approach was that it allowed the capture of what was provided by employers in terms of washing supplies; in about one-third of the observed opportunities for washing (all at a single farm), adequate supplies were unavailable. Additionally, because of the observational design of this study, workers' utilization of nonmandated safety practices could be explored. Hats, as well as using water-resistant outerwear and gloves, were worn often in the field. In light of this finding, the efficacy of hats and ponchos in minimizing exposures to agricultural pesticides should be evaluated.

High levels of training, recent training, and experience in agriculture suggested that implementation of PPBs among this group would be high, and this was the case for self-reported and observed use of closed shoes, socks, long pants, and long sleeves; however, the observed engagement in PPBs the WPS required be taught was inadequate in the area of washing behaviors, raising concern about this pathway for pesticide exposure. The most important implication from study findings is the need for targeted intervention and education to improve washing behaviors in the field for Latino migrant and seasonal farmworkers.

Prior research has shown that the number of people reporting hand washing behaviors before eating matches the number reporting availability of water for hand washing (Ciesielski et al., 1994). In this study, because participants entered sheds that the primary investigator did not, rode on buses where there could have been hand sanitizer, and engaged in other activities not visible in the field, observations of washing supplies were possible only 23% of the time. However, 67% of the observations made of washing supplies available before eating showed supplies were adequate (i.e., soap and water were provided and, less commonly, paper towels were available). When adequate supplies existed, farmworkers used them to wash hands only 35% of the time before eating and only 13% of the time before drinking. Therefore, the provision of supplies is not the only, or perhaps even the most important, barrier to hand washing, and other farmworker-based factors should be considered.

The finding that 33% of observations showed that there were no supplies available needs attention. It would be difficult for a worker to consider washing routine and easy-to-implement if supplies are unavailable one-third of the time. Growers, even those oriented

toward safety, must be vigilant about the consistent provision of washing supplies. The U.S. Department of Labor has field sanitation standards that mandate both the provision of single-use towels (Occupational Safety and Health Administration, 2011), and those specific to the State of North Carolina cite the need for a potable water tank and appropriate cleansers (North Carolina Department of Labor, 2005). While the sample of farms is not of adequate size to draw generalizable conclusions, it was found in this study that the two smaller farms (with an average of 6 workers) were able to consistently provide soap and water across the entirety of the work day for their workers. The larger farm (with 60 workers) had greater variability in the availability of supplies throughout the workday, an observation perhaps related to the fact that on this farm, workers and supplies were transported between fields. Furthermore, the use rate of supplies was different across the three farms and did not correspond directly to the availability of supplies, as had been previously found (Ciesielski et al., 1994).

An interesting finding was that farmworkers used several protective behaviors that are not required to be taught by the WPS and that likely stem from their own experiences and informal peer training. Gloves have been shown to be effective in minimizing exposures (Hernandez-Valero et al., 2001; Salvatore et al., 2008), and gloves were used, albeit inconsistently over the course of the day and by work task and farm. One farm had no glove utilization by workers, and a second had glove utilization by less than half of its workers. This finding could be related to temporal differences in observations and workers' perceptions that the work tasks observed at the first two farms (weeding and topping/suckering, respectively) are less dangerous than work tasks that came later in the season (such as harvest observed at the third farm). Glove use may be beneficial at any point in the process in which one is likely to come in contact with tobacco that has been treated with pesticides. However, glove use by workers may lead to a false sense of safety and the feeling that one does not need to hand wash after removing gloves because the gloves protect him/her. The video used for training on two of the farms (which trains to the level of the pesticide handler) demonstrates the proper technique for removing gloves and then washing hands (Michigan State University Extension, 1994).

The use of water-resistant outerwear was added to observation and field notes when we saw its widespread use. The use of outerwear to keep clothes from becoming wet and thus less permeable may be promising in terms of reducing exposures to pesticides as well as reducing green tobacco sickness, a form of nicotine poisoning that occurs by dermal absorption of nicotine from tobacco leaves when the plants are wet. Farmworkers used raincoats or trash bags with belts to minimize exposure to liquids. The efficacy of homemade and repurposed water-resistant outerwear in minimizing exposures to pesticides and nicotine deserves further exploration. Furthermore, water-resistant clothing can increase risk for heat illness, and it is stated that employers should provide additional opportunities for water, rest, and shade (OSHA, 2015) when they are in use. Additionally, almost all workers wore a hat. The use of wide-brimmed hats minimizes sun exposure and the risk for skin cancer (National Institute for Occupational Safety and Health, 2014); however, as described above, only 15% of the hats used were wide-brimmed hats. More investigation into the rationale for using baseball caps should be made. Because farmworkers often placed

tobacco leaves on their heads to carry them to tractors during harvest, hats may protect against exposure in this way as well.

It has been found that farmworkers with more years of experience and with work visas tend to work and live in camps with better sanitation conditions, including access to more washing facilities (Whalley et al., 2009). In addition to working on farms motivated toward safety by virtue of having elected to participate in the Certified Safe Farm intervention (East Carolina University, 2012), the majority (90%) of the farmworkers in this study were in the United States on a work visa (e.g., H2A) and not naive with regard to farm work. On average, they had worked in the United States for six seasons and outside of the United States for 12. Participating farmworkers also reported high levels of training compared to farmworkers described in prior literature. The vast majority of participants reported receiving pesticide safety training (97%), with 80% indicating that the training was provided as recently as the current season. Our study had higher rates of training than a prior study (N = 287) in which 80% had training in current the season but the other 20% had no training at all (Arcury et al., 2009).

Based on the observations of farmworker PPB in this study, a video method alone may be insufficient for training workers, and it is possible that videos underemphasize the protective value of hand and face washing. Prior reported concerns about video training include lack of time for questions, the ability for trainees to look away and not engage with the video, and not meeting the needs of non-Spanish speakers (Larson, 2000). We found a high level of training, but there was nevertheless a failure to implement PPBs, especially washing behaviors.

As previously mentioned, the participants had significant prior agricultural experience. A prior study reported that use of protective clothing (gloves, socks, and hats) was lowest for farmworkers working in agriculture for more than 10 years (Levesque et al., 2012b). We found a similar decline in use of protective clothing after 9 years. While both significant and non-significant findings can be found, studies in other occupations like healthcare have found that years of experience don’t necessarily translate into good handwashing practices (Suchitra & Devi, 2007), nor the use of certain PPE like gowns for nurses administering hazardous drugs (Martin & Larson, 2003), suggesting that some protective behaviors may decline with work experience. Utilizing peer leaders with only moderate agricultural experience as trainers in discussions and practice sessions could be beneficial. The use of an observational method was valuable. As it enabled the observation of nonmandated behaviors in the field, captured behaviors and supply availability that varied across the course of the day, and served as a valuable comparison to self-reported behaviors.

The limitations of this study include its small sample size, particularly of farms, and a bias toward workers on farms motivated toward safety, having recruited farmworkers from farms that participated in the CSF intervention (East Carolina University, 2012). Furthermore, only one crop in one geographic region in the state was explored. Finally, the study took place on farms sequentially over the course of the growing season, with more data collected during harvest than any other point in the season. Also, farmworkers could not be observed in every possible time point. Out of 1,442 possible observation data points, approximately 350 (24%)

were missing because of inability to view the worker, either because he/she left the field, or more commonly, because he/she was too far away in the field to be observed. Capturing this 24% by following workers through the field would have required the primary investigator to travel with the workers on tractors through the field and would have changed the nature of the observations. Acknowledging that some data will be missing with this form of inquiry is essential.

No known studies to date have reported using an observational method to ascertain which PPBs are practiced by Latino migrant and seasonal farmworkers, or focused on the set of behaviors recommended in the WPS in particular. The use of an observational method, as well as a comparison with self-report data, gives insight into what may have been overreported in previous studies (Arcury et al., 1999; Ciesielski et al., 1994; Hernandez-Valero et al., 2001; Levesque et al., 2012a, 2012b; Salvatore et al., 2008). Extensive field notes further contextualized findings, such as understanding what type of shoes were worn by farmworkers, the availability of washing supplies, and the frequency of PPBs not required to be taught by the WPS but also believed to be protective.

Study findings resonate with previous studies of self-reported PPBs among Latino migrant and seasonal farmworkers in North Carolina that have found that, even when trained, workers do not report practicing all of the behaviors that they learned to protect themselves (Arcury et al., 1999; Cabrera & Leckie, 2009). While consistently high use of long pants and closed shoes was found across both observational and self-reported methods of inquiry, other PPBs were implemented less often than would be desired for farmworker protection. Use of long sleeves, socks, and protective shoes in particular should be reinforced in the field after pesticide safety training, as they were not used by all workers all of the time, despite self-reports to the contrary. Gloves, while not mandated, are also considered an effective protective behavior and should be encouraged. An investigation into the efficacy of repurposed or homemade water-resistant outerwear for minimizing pesticide exposure should be conducted. Washing behaviors in the field are the most concerning of farmworker PPBs; while those behaviors are reported at a high level, observations indicated very little hand-washing behavior and no washing of the face in particular before eating or drinking. The importance of these behaviors needs to be stressed during the initial pesticide safety training and reinforced over the course of the season. The availability of washing supplies must also be consistently enforced per the field sanitation standards established by the North Carolina Department of Labor (North Carolina Department of Labor, 2005) and the most recent revision to the WPS.

In summary, this study contributes to understanding PPBs actually practiced by Latino migrant and seasonal farmworkers. With recent revisions to the WPS, an examination of the extent to which the current standard is actually being implemented is needed both at the informational and structural level. Furthermore, targeted education about utilization and removal of gloves and the washing of hands and faces in the field prior to eating and drinking will be timely and informed by the needs reflected in current agricultural practice.

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Highlights

- This study compared observed and self-reported pesticide protective behaviors of 71 Latino migrant and seasonal farmworkers.
- Protective clothing behaviors were widely practiced and reported.
- Washing of hands and face before eating and drinking in the field were significantly over-reported.
- Targeted strategies to improve washing in the field are warranted.

Table 1

Farmworker Personal Characteristics

Personal Characteristics	*Mean* (*SD*)	Frequency (%)
Demographics		
Age	32.75 (11.5)	
Gender		
Male		69 (96%)
Female		3 (4%)
Marital status		
Married		36 (50%)
Civil union		20 (28%)
Not married		16 (22%)
Latino Ethnicity		72 (100%)
Home country		
Mexico		70 (97%)
Honduras		2 (3%)
Agricultural Experience		
Seasons lived in the United States	6.5 (5.6)	
Years worked in agriculture outside of the United States	12.3 (10.3)	
Years worked in agriculture in the United States	6.36 (5.6)	
Years worked in tobacco	6.99 (5.6)	
Worker Status		
Traveled to another (additional) farm/city for agricultural work in last 12 months		
Yes		7 (10%)
No		65 (90%)
Live on the farm where you work		
Yes		69 (96%)
No		3 (4%)
In the United States on a work contract		
Yes		65 (90%)
No		7 (10%)
Highest Level of Education Completed		
Less than middle school		26 (36%)
Middle school		38 (53%)
Some high school or beyond		8 (11%)
English Proficiency		
Skill in reading English		
None or very little		69 (96%)
Some		3 (4%)
Pesticide Safety Training		
Type of training		
None		3 (4%)

Personal Characteristics	***Mean* (*SD*)**	**Frequency (%)**
Video		68 (94%)
Presentation/discussion		6 (8%)
Practice session		7 (10%)
Year of last pesticide safety training		
Never		2 (3%)
2012 or 2013		12 (17%)
2014		58 (80%)

Table 2

Frequency of Implementation of Pesticide Protective Behaviors Among 71 Farmworker Participants

Behavior	None of the Time	Some or Most of the Time	All of the Time
Wearing closed shoes	0	6 (9%)	65 (91%)
Wearing socks[a]	2 (15%)	0	11 (85%)
Wearing long sleeves	1 (1.5%)	6 (8.5%)	64 (90%)
Wearing long pants	0	1 (1.5%)	70 (98.5%)
Washing hands before eating[b]	34 (83%)	0	7 (17%)
Washing face before eating[b]	41 (100%)	0	0
Washing hands before drinking[c]	62 (90%)	7 (10%)	0
Washing face before drinking[c]	69 (100%)	0	0
Wearing a hat	0	5 (7%)	66 (93%)
Wearing gloves	14 (20%)	29 (41%)	28 (39%)
Wearing water-resistant outerwear	23 (32%)	44 (62%)	4 (6%)
Use of hand sanitizer	71 (100%)	0	0

[a] There were 58 people for whom the use of socks could not be observed; $N = 13$.

[b] There were 30 people for whom eating was not observed; $N = 41$.

[c] There were 2 people for whom drinking was not observed; $N = 69$.

Table 3

Behavior Variation by Time

Behavior	Overall Nonadherence (1,442 Observations) *n* (%)	Nonadherence Before 11:00 a.m. [a] *n* (%)	Nonadherence After 11:00 a.m. *n* (%)
Wearing closed shoes	23 (2%)	10 (44%)	13 (56%)
Wearing long-sleeved shirt	72 (5%)	20 (28%)	52 (72%)
Wearing gloves	310 (21%)	112 (36%)	198 (64%)
Washing hands before drinking	234 (16%)	74 (32%)	160 (68%)
Washing hands before eating	44 (3%)	29 (66%)	15 (34%)

[a] 11:00 am was chosen as it was when the highest heat of the day began and came after a morning break.

Table 4

Self-Reported Behaviors of 72 Farmworkers

Behavior	No	Sometimes	Yes
"Do you normally … ?"			
Work in closed shoes	0	5 (7%)	66 (93%)
Work with socks on	0	1 (1.5%)	70 (98.5%)
Work using a shirt with long sleeves	1 (1.5%)	1 (1.5%)	69 (97%)
Work using long pants	0	0	71 (100%)
Use gloves while you work	3 (4%)	9 (13%)	59 (83%)
Wash your face before eating	10 (16%)	15 (21%)	46 (63%)
Wash your hands with soap and water before eating	2 (3%)	4 (6%)	65 (91%)
Wash your hands with hand sanitizer before eating	40 (56%)	12 (17%)	19 (27%)
Wash your face before drinking	22 (31%)	18 (25%)	31 (44%)
Wash your hands with soap and water before drinking	15 (21%)	15 (21%)	41 (58%)
Wash your hands with hand sanitizer before drinking	22 (31%)	20 (28%)	29 (41%)
Shower after direct contact with a pesticide	8 (11%)	1 (1.5%)	62 (87.5%)
Re-wear any work clothes, including socks and underwear, without washing them	67 (94%)	0	4 (6%)
Take empty pesticide containers home	71 (100%)	0	0
Take pesticides home	71 (100%)	0	0
Enter restricted areas in the field	64 (90%)	3 (4%)	4 (6%)
Change clothes after work	0	1 (1.5%)	70 (98.5%)
Wash your hands before using the bathroom	5 (7%)	9 (13%)	57 (80%)
Stay out of areas the boss tells you not to enter	0	0	71 (100%)
Normally keep children away from pesticides	0	1 (1.5%)	64 (98.5%)
Normally have work clothes washed separately from nonwork or family clothing	1 (1.5%)	0	70 (98.5%)

Table 5

Comparison of Observed and Self-Reported Behaviors of Farmworkers

Behavior	Never No	Some or Most of the Time Sometimes	All of the Time Yes	Wilcoxon Test
Clothing				
Wearing closed shoes, 3 types[a]				−.38 (p = .705)
Observed	0	6	65	
Reported	0	5	66	
Wearing socks[b]				.00 (p = 1.00)
Observed	2	0	11	
Reported	0	1	79	
Wearing long sleeves				−2.20 (p = .028)
Observed	1	6	64	
Reported	1	1	69	
Wearing long pants				−1.41 (p = .157)
Observed	0	1	70	
Reported	0	0	71	
Washing				
Washing hands before eating[c]				−4.77 (p =<0.001)
Observed	34	0	7	
Reported	2	4	65	
Washing face before eating				−4.54 (p =<0.001)
Observed	41	0	0	
Reported	10	15	46	
Washing hands before drinking[d]				−4.06 (p = <0.001)
Observed	62	7	0	
Reported	15	15	41	
Washing face before drinking				−1.90 (p = .058)[e]
Observed	69	0	0	
Reported	22	18	31	
Non-WPS mandated				
Wearing gloves				−5.00 (p =<0.001)
Observed	14	29	28	
Reported	3	9	59	

[a] See observed behavior table; not all shoes used were protective.

[b] For 58 people the use of socks could not be observed, N=13.

[c] There were 30 people for whom eating was not observed N = 41.

[d] There were 2 people for whom drinking was not observed; N = 69.

[e] Trend.