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Association between Workplace and Housing Conditions and Use of Pesticide Safety Practices and Personal Protective Equipment among North Carolina Farmworkers in 2010

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Association between Workplace and Housing Conditions and Use of Pesticide Safety Practices and Personal Protective Equipment among North Carolina Farmworkers in 2010

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Abstract

Background: There are inconsistencies about the effects of farmworker housing and workplace conditions and use of self-protective behavior practices and personal protective equipment (PPE).

Objective: To investigate the association between workplace and housing conditions and farmworker use of pesticide safety practices and PPE.

Methods: This study was conducted in 4 counties in North Carolina, USA, from July to October, 2010, during the agricultural growing season. Farmworkers working in agriculture aged 18 to 62 (n=187) were administered a structured questionnaire to collect self-reported measures on housing and workplace conditions. Use of pesticide safety and PPE were examined by asking questions about wearing gloves, wearing socks, and wearing a hat. Chi-square and multiple logistic regression analyses were used for statistical analyses.

Results: Farmworkers reporting availability of enough hot and cold water for bathing and doing laundry were 13.6 times more likely to use pesticide safety practices (adjusted OR: 13.6, 95% CI: 1.4–135.4), whereas, those who reported that soap for handwashing was always or usually available while doing agricultural work were 7.8 times more likely to use pesticide safety practices (adjusted OR: 7.8, 95% CI: 3.3–18.5). Farmworkers that reported access to water to wash their hands with while performing agricultural work were more likely to use PPE (adjusted OR: 3.4, 95% CI: 1.3–9.2).

Conclusions: Some migrant farmworker labor camps are not supplying acceptable housing conditions such as 1 handwashing sink per 6 people (n=10, 5.4%). Use of pesticide safety practices and PPE is greater when farmers provide decontamination supplies. Improvement of housing and workplace conditions are crucial to increase use of pesticide safety practices and PPE.

Keywords: Pesticides; Protective devices; Safety management; Agricultural workers' diseases; Housing; Workplace; Poisoning; Occupational health services

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Introduction

For more information on clinical and biochemical parameters of children and adolescents applying pesticides see www.theijoem.com/ijoem/index.php/ijoem/article/view/41

Farmworkers and their families suffer disproportionately from workplace pesticide exposure. Although US Environmental Protection Agency Worker Protection Standard (EPA WPS) and Occupational Safety and Health Administration (OSHA) sanitary field regulations are in place to enforce safe and healthy work conditions,[1,2] pesticide poisoning incidence rates remain extremely high for agricultural workers. A study funded by the National Institute for Occupational Safety and Health[3] reported that pesticide poisoning incidence rates (IR) for agricultural workers in the United States were 38.9 times higher than all other industries combined (agricultural workers, 53.6 IR and nonagricultural workers, 1.4 IR). The US EPA estimates 10 000 to 20 000 physician-diagnosed pesticide poisonings and 300 000 acute pesticide poisonings occur annually among farmworkers in the United States.[4] Acute pesticide poisoning among farmworkers is difficult to estimate due to the lack of pesticide poisoning surveillance systems designed specifically to monitor pesticide poisoning among farmworkers, farmworkers lack of understanding of acute pesticide poisoning symptoms whereas they do not seek medical treatment, and farmworkers that do not report pesticide poisonings due to workplace sanctions. These findings indicate a dire need to closely examine the influence of workplace and housing conditions on farmworker use of pesticide safety behavior practices.

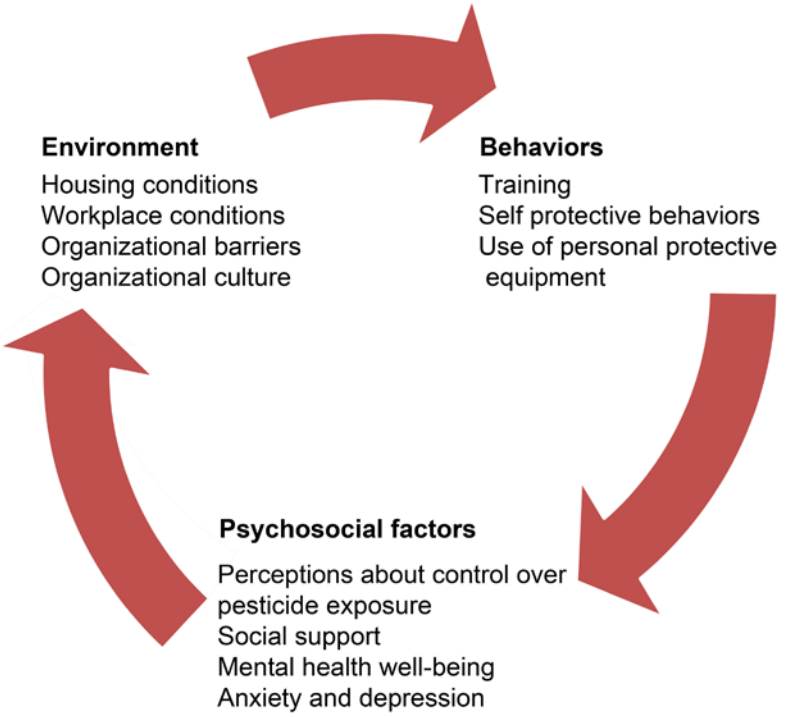

Figure 1: Cycle between environmental, behavioral, and psychosocial factors and pesticide exposure and pesticide safety practices.

Several researchers have found associations between pesticide exposure and chronic health effects that include lung cancer, prostate cancer, lymphohemopoietic cancers, pancreatic cancer, and colorectal cancer.[5-9] Other scholars reported a significant association between neurological symptoms and pesticide exposure.[10,11] Bronchitis, asthma, wheezing, farmer's lung, and rhinitis have also been reported to be associated with respiratory morbidity among farmworkers.[12-15]

OSHA field sanitation standards require employers of 11 or more field workers to meet specific requirements to reduce illness among farmworkers. Employers are required to provide potable drinking water dispensed in single use drinking cups or fountains and one toilet and handwashing facility that includes soap and single use towels per 20 farmworkers located within a quarter mile walk.[2] Although, previous studies have investigated farmworker workplace conditions,[16-20] a wide gap in knowledge still exists as to whether agricultural employers are providing the items required under OSHA field sanitation regulations. Breaking the cycle of pesticide exposure among

farmworkers cannot be accomplished without considering environmental, behavioral, and psychosocial factors which play a role in predisposition of pesticide exposure (Fig 1).

Availability of acceptable housing and workplace conditions plays a vital role in increasing farmworker use of pesticide safety practices. Previous studies support the need to continue to investigate how housing conditions affect the risk of pesticide exposure and use of pesticide safety practices, which is crucial to reduce health disparities among farmworkers and their families.[21-23] Exploring environmental determinants that may influence farmworker safety behavior practices is necessary to promote healthy and safe behavior change practices. The aim of this study was to evaluate impact of housing and workplace conditions on farmworker use of pesticide safety practices.

Materials and Methods

This study was conducted in four counties (Stokes, Yadkin, Surry, and Rowan) in North Carolina, USA, from July to October, 2010, during the agricultural growing season. Nonprobability purposive sampling was used to recruit 187 farmworker participants by using the NC Department of Labor website that lists locations of labor camps in all the counties in North Carolina and provides the number of seasonal workers and arrival and departure dates of the workers. A list of directions obtained from the North Carolina Department of Labor Migrant Housing Map Site was used to identify labor camps that were used for site visits to recruit participants. Recruitments flyers were also placed in Mexican restaurants and stores.

Pilot Study

A questionnaire was designed by using relevant questions in a previously developed survey, Farm Safety among North Carolina Farmworkers, that was part of the Preventing Agricultural Chemical Exposure (PACE) among North Carolina farmworkers project.[24] The PACE project recruited participants throughout eight counties in the eastern part of North Carolina. Prior to conducting the present study, a pilot study was used to assess the reliability and validity of the questionnaire due to the addition of questions about housing and workplace conditions. The modified questionnaire, North Carolina Farmworker Pesticide Safety Survey Questionnaire was assessed for validity (content, construct, and face validity) and reliability (internal consistency and test-retest reliability). Fifteen participants that were farmworkers, five interviewers, and two experts that specialize in research on pesticide exposure among migrant and seasonal farmworkers participated in the pilot study. Internal consistency of the modified survey instrument was determined by using Cronbach's alpha coefficient.[25] Test-retest reliability of the additional questions about housing predictors were evaluated by using intraclass correlation coefficient (ICC) two-way random effect model for paired measurements.[26]

For more information on the questionnaire see the article's *Web-extra* on our Web site.

Three forms of validity—face, content, and construct validity—were used to assess the validity of the questionnaire. Several questions were removed and/or revised based on participant feedback.

Cronbach's alpha coefficient of internal consistency was 0.86 for housing conditions and 0.96 for workplace conditions. ICC of the questions on housing conditions ranged from 0.87 to 1.0.

Participants

This study was approved by Walden University Institutional Review Broad for human research. Participants met the following inclusion criteria to be part of this study: all farmworkers had to be age 18

TAKE-HOME MESSAGE

- Pesticide poisoning rates remain extremely high for farmworkers regardless of current regulations in place aimed to reduce pesticide exposure among farmworkers.
- Current workplace and housing conditions are not acceptable to ensure that farmworkers have access to pesticide decontamination supplies and equipment.
- Improvement of workplace and housing conditions will increase farmworker use of pesticide safety practices.

to 62 years, had to be employed in farmwork within the past 12 months, and had to be employed in farmwork at least 50% of the time. Participants were recruited throughout four counties (Stokes, Yadkin, Surry, and Rowan) in the northern part of North Carolina.

Data Collection

A cross-sectional quantitative study design was used to measure the relationship between the housing and workplace conditions associated with use of pesticide safety practices among the farmworkers. Five bilingual interviewers were recruited, trained, and paid to administer face to face interviews. Interviewers were trained to ensure that they understood the questionnaires, confidentiality measures, and proper guidelines for conducting the interviews.

Throughout the data collection period, interviewers were supervised daily as the interview packets were returned and a supervisor was always at the general location where the surveys were being conducted so that the interviewers could ask questions and seek information if needed. At the completion of the interview, each participant received a US$ 10.00 gift card and a brochure published by the US EPA[27] in Spanish and English on how to protect themselves against pesticides.

Outcome Variables

Two outcome variables were used to measure farmworkers use of pesticide safety practices (SAFETY)—the main outcome variable—and use of personal protective equipment (PPE)—the secondary outcome variable.

Pesticide safety practices (main outcome variable): One question on the survey was used to quantify use of pesticide safety practices among the farmworkers. The participants were asked if they did anything to protect themselves against pesticides while working in the fields; the question was independently coded. Dependent source variable PFWK (protect yourself from pesticides while working in the fields) originally coded as '4' yes, always; '3' yes, usually; '2' yes, sometimes; and '1' no, never was recoded and collapsed into two categories: Value labels for the new variable, SAFETY '1' equaled "yes" (for all original PFWK label values '4' yes, always; and '3' yes, usually) and '0' equaled "no" (for all original PFWK label values '2' yes, sometimes; and '1' no, never).

Personal protective equipment (secondary outcome variable): PPE was defined as wearing gloves, wearing socks, and wearing a hat or cap while working in the fields. All participants were asked whether they wore gloves, wore socks, and wore a hat or cap within the past month while working in the fields. These variables were coded as '1' equaled "yes" and '0' equaled "no." A collective variable was constructed by creating an index by adding all three variables together and calculating the average. Value labels for the new variable use of personal protective equipment '1' equaled "yes, used

personal protective equipment" and '0' equaled "did not use personal protective equipment."

Housing and Workplace Conditions (Predictor Variables)

Workplace conditions: Questions were asked to capture data on farmworker workplace conditions by asking questions which included items such as availability of i) drinking water, ii) decontamination water, iii) hand soap, iv) single use towels, v) toilet facilities in close proximity to the fields, vi) cups, vii) water to wash hands while working in the fields, viii) washing water separate from drinking water, ix) place to shower or bathe after work, x) information about pesticides posted where it could be seen, and xi) boss talk to you about working safely. Questions about what type of work farmworkers were doing when they came into contact with pesticides included contact by i) working in a greenhouse, ii) setting plants out, iii) cultivating, iv) topping or suckering, and v) harvesting. Several questions were asked about how contact occurred with pesticides while working within the past two weeks. These questions were about dichotomous variables which included contact by i) touching crops or plants after pesticides were applied, ii) by breathing pesticides in the air, iii) by being sprayed, iv) by swallowing sweat off face, v) when mixing loading or applying pesticides, vi) when riding on equipment, vii) from residue on plants, and viii) other mode of contact.

Housing conditions were measured by asking 10 questions about housing conditions. These questions included i) live in housing on a farm or off a farm, ii) live in housing that belongs to grower or does not belong to a grower, iii) who lives with you (*e.g.*, workers only or relatives and workers), iv) number of people living where you sleep, v) how many bathrooms in the building or trailer where you live, vi) does the building or trailer where you live have air conditioning, vii) where you wash your clothes, viii) does the building or trailer where you live have enough hot and cold water for bathing and doing laundry, ix) does the building or trailer where you live have one showerhead per 10 people, and x) does the building or trailer where you live have one hand washing sink per six people.

Statistical Analyses

After the questionnaires were completed, a codebook was constructed to describe the locations of the variables and list the assignments of the codes to the attributes that compose the variables. Data cleaning was performed to import the data into Stata, revise names and labels, verify that each variable was correct, recode variables and verify that they were created correctly, and extracting a subset of variables for analysis. STATA/IC 11.0 statistical software package was used for data analysis. Univariate descriptive analysis was used to examine the distribution of each variable. Bivariate analysis (χ^2) was used to examine the relationship between the independent and dependent variables and multiple logistic regression analysis was used to predict the most significant independent variables associated with use of pesticide safety practices. Backward stepwise multiple logistic regression analysis was used to identify all independent variables associated with the outcome variable at a p value of <0.05 after adjusting for age, education, and agricultural background.

Results

Demographic and Occupational Characteristics

A total of 187 surveys were completed by

For more information on existence of insecticides in drinking water in a governorate in Egypt see www.theijoem.com/ijoem/index.php/ijoem/article/view/122

Table 1: Distribution of farmworker housing conditions categorical measures (n=187)

Housing Conditions	n (%)
Housing	
Live in housing on farm	180 (96.3)
Live in housing off farm	7 (3.7)
House belong to grower	
Live in house that belongs to grower	184 (98.4)
Live in house that does not belong to grower	3 (1.6)
Who lives with you	
Live with other relatives	16 (8.6)
Live with relatives and other workers	50 (26.7)
Live with other workers only	118 (63.1)
Number of people living where you sleep	
4 or less people	38 (20.3)
5 to 9 people	136 (72.7)
10 or more people	11 (5.9)
Bathroom	
No bathroom	5 (2.7)
One bathroom	129 (69)
Two bathrooms	53 (28.3)
Where you wash your clothes	
Washing machine where I live	180 (96.3)
Laundromat	6 (3.2)

farmworkers in Surry, Stokes, Yadkin, and Rowan counties in North Carolina. All farmworkers were male (n=187) and 95% (n=177) reported Mexico as their permanent home. Spanish was the only language spoken by the majority of participants (95%, n=178) and more than four-fifths of the farmworkers reported that they understood very little or no English. The majority of farmworkers were 31 to 45 years old (36%, n=67). More than one half of the farmworkers (56%, n=105) reported a sixth grade or less education level, and 82% (n=154) reported they were married or living as married.

All of the participants reported working in fields; 93% (n=174) were under a work contract from Mexico, and approximately 86% (n=160) reported that they did not move from place to place to do farmwork. The majority of farmworkers (99.5%, n=186) worked in tobacco fields. More than one-third of the farmworkers (37%, n=69) worked in agriculture for 6 to 10 years and more than one half of the farmworkers (56%, n=105) worked in agriculture four months or less during the year.

Results for the main outcome variable, "protect yourself from pesticides while working in the fields" (SAFETY) indicated that approximately one-third of the farmworkers (35%, n=65) did not do anything to protect themselves from pesticides while working in the fields. The US EPA WPS concepts of basic pesticide safety information include protective methods to prevent pesticide exposure by i) following directions and/or signs about keeping out of treated or restricted areas, ii) washing before eating, drinking, using chewing gum or tobacco, or using the toilet, iii) wearing work clothing that protects the body from pesticide residues, iv) washing/showering with soap and water, shampoo hair and put on clean clothes after work, v) washing work clothes separately from other clothes before wearing them again, and vi) washing immediately in the nearest clean water if pesticides are spilled or sprayed on the body and, as soon as possible, showering, shampooing, and changing into clean clothes.[1]

Results for the secondary outcome variable, "use of personal protective equipment" (PPE3) while working in the fields within the past month indicated

that more than one-fourth of the farmworkers (27%, n=50) did not use PPE when working in the fields (wear gloves, wear socks, and wear a hat or cap).

Housing Conditions

Descriptive statistics indicated that the majority of farmworkers (98%, n=184) lived in housing that belonged to the grower and that 3% (n=6) of farmworkers reported there was not enough hot and cold water for bathing and doing laundry. The majority of farmworkers (82%, n=153) reported that farmworker labor camps did not have air conditioning and 6% (n=11) reported 10 or more people lived where they slept (Tables 1 and 2).

Housing Conditions and Use of Pesticide Safety Practices

Results for backward stepwise multiple logistic regression analysis indicated that farmworkers that reported living with relatives and other workers were 9.4 times more likely to use pesticide safety practices (adjusted OR: 9.4, 95% CI: 2.1–43.0). Use of pesticide safety practices were 12.9 times greater for farmworkers that reported living only with other workers (adjusted OR: 12.9, 95% CI: 2.9–56.8). The odds of using pesticide safety practices were 13.6 times greater among farmworkers reporting availability of enough hot and cold water for bathing and doing laundry (adjusted OR: 13.6, 95% CI: 1.4–135.4). Farmworkers that reported they had air conditioning where the sleep were five times more likely to use pesticide safety practices (adjusted OR: 5.3, 95% CI: 1.5–19.0) (Table 3).

Housing Conditions and Use of Personal Protective Equipment

Farmworkers that reported they had completed the seventh grade or higher were 2.9 times more likely to use PPE (adjusted OR: 2.9, 95% CI: 1.3–6.2). The odds of using PPE were 5.8 times more likely among farmworkers that reported there was one handwashing sink per six people in the building or trailer where they slept (adjusted OR: 5.8, 95% CI: 1.3–27.2) (Table 4).

Table 2: Distribution of farmworker housing condition dichotomous measures (n=187)

Housing Conditions	Yes	No, don't know, not sure
	n (%)	n (%)
Air conditioning	33 (17.7)	153 (81.8)
Hot and cold water	181 (96.8)	6 (3.2)
Showerhead per 10 people where you live	180 (96.3)	6 (3.2)
One hand washing sink per 6 people	176 (94.1)	10 (5.4)

Workplace Conditions

The majority of farmworkers (99%, n=185) reported that drinking water was always or usually available in the fields, however only 82.4% (n=154) reported that water was always or usually available to wash their hands while working in the fields. More than one-forth of the farmworkers (26.7%, n=50) reported that toilet facilities were seldom or never available within one-fourth of a mile of the distance of the place that they were working in the fields. More than one-forth of the farmworkers (27.3%, n=51) in the present study reported that soap for handwashing was seldom or never available. Results from questions about contact with pesticides at work indicated that approximately one-fifth of the farmworkers (17.7%, n=33) were not told when pesticides were being applied or recently applied and more than one-fourth of farmworkers (26.2%, n=49) reported there was no information posted about pesticides where they could see the

Table 3: Multiple logistic regression analysis results of housing and workplace conditions associated with use of pesticide safety practices (SAFETY)

Independent Variable	Pesticide Safety Practices	
	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
Housing Conditions		
Live in a house that belongs to grower	0.38 (0.08–1.78)	NS
10 or more people living where you live	6.52 (0.76–56.33)	NS
Live with relatives and other workers	5.33 (1.50–19.0)	9.43 (2.07–42.95)
Live with other workers only	7.41 (2.23–24.60)	12.93 (2.94–56.82)
Hot and cold water for laundry and Bathing	10.08 (1.15–88.24)	13.56 (1.36–135.42)
Air conditioning	2.82 (1.10–7.25)	5.25 (1.45–19.04)
Workplace Conditions		
Soap available for hand washing	5.65 (2.93–10.89)	7.82 (3.30–18.54)
Information about pesticides posted Where you can see it	1.59 (0.81–3.10)	3.31 (1.31–8.38)
Place to shower or bathe after work	0.22 (0.03–1.80)	0.05 (0.00–0.58)
Contact with pesticides by swallowing Sweat off face	0.31 (0.14–0.69)	0.07 (0.02–0.25)
Told when pesticides are being applied Or recently applied	3.17 (1.47–6.82)	4.36 (1.59–11.93)
Cups available for each worker	3.56 (1.00–12.65)	NS
Water to wash hands while working in The fields	6.13 (2.69–13.96)	NS
Soap for handwashing	5.65 (2.93–10.89)	NS
Single use towels	3.46 (1.84– 6.50)	NS
Toilet facilities near fields	2.32 (1.24–4.32)	NS
Boss talk to you about pesticide safety	12.20 (1.44–103.70)	NS
Contact with pesticides while setting Out plants	2.64 (1.14–6.13)	NS
Contact with pesticides while cultivating	0.66 (0.33–1.30)	NS
Contact with pesticides by being sprayed	0.36 (0.15–0.88)	NS
Contact by swallowing sweat off face	0.31 (0.14–0.69)	NS
Contact by mixing, loading, and applying pesticides	0.37 (0.12–1.11)	NS

$p<0.05$ was considered significant
*Model adjusted for all variables in the model and (age, education, and agricultural background)
NS: Not significant; CI: Confidence interval

Table 4: Multiple logistic regression analysis results of housing and workplace conditions associated with use of personal protective equipment (PPE3)

Independent Variable	Personal Protective Equipment	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Housing Conditions		
5 to 9 people living where you sleep	1.92 (0.87–4.21)	NS
10 or more people living where you sleep	0.30 (0.07–1.20)	NS
Where you wash your workclothes	0.35 (0.07–1.81)	NS
One handwashing sink per six people	7.44 (1.84–30.07)	5.84 (1.26–27.21)
Workplace Conditions		
Water to wash while working in the fields	3.32 (1.52–7.26)	3.43 (1.28–9.21)
Place to shower or bathe after work	3.67 (0.94–14.25)	NS
Told when pesticides are being applied or recently applied	1.77 (0.82–3.79)	NS
Know names of pesticides	4.21 (1.57–11.28)	8.41 (2.69–26.32)
Signs in treated fields	0.32 (0.14–0.71)	NS
Contact with pesticides while topping and suckering	2.19 (1.13–4.23)	NS
Contact with pesticides by touching crops and plants	2.09 (1.08–4.06)	NS
Contact by breathing pesticides in the air	5.55 (2.22–13.89)	6.36 (2.33–17.42)
Contact by being sprayed	2.68 (0.76–9.44)	NS

p<0.05 was considered significant
*Model adjusted for all variables in the model and (age, education, and agricultural background)
NS: Not significant; CI: Confidence interval

information (Table 5).

Workplace Conditions and Use of Pesticide Safety Practices

Farmworkers that reported soap for handwashing was always or usually available while doing agricultural work were 7.8 times more likely to use pesticide safety practices compared to farmworkers that reported soap for handwashing was seldom or never available (adjusted OR: 7.8, 95% CI: 3.3–18.5). Information about pesticides posted where farmworkers could see it increased use of pesticide safety practices 3.3 times compared to farmworkers that did not report that information about pesticides was posted where they could see it (adjusted OR: 3.3, 95% CI: 1.3–8.4). Farmworkers were 93% less likely to use pesticide safety practices that reported they had contact with pesticides by swallowing sweat off their face (adjusted OR: 0.07, 95% CI: 0.02–0.25). Similarly, farmworkers were 4.4 times

Table 5: Distribution of farmworker workplace conditions (n=187)

Workplace Conditions	Yes	No
	n (%)	n (%)
Told when pesticides are being applied or recently applied	153 (81.8)	33 (17.7)
Know names of pesticides	48 (25.7)	138 (73.8)
Information about pesticides posted where you can see it	137 (73.7)	49 (26.3)
Signs in treated fields	120 (64.9)	65 (35.1)
Contact with pesticides while working in greenhouse	21 (11.2)	166 (88.8)
Contact with pesticides while setting out plants	41 (21.9)	146 (78.1)
Contact with pesticides while cultivating	45 (24.1)	142 (75.9)
Contact with pesticides while topping and suckering	105 (56.2)	82 (43.9)
Contact with pesticides while harvesting	113 (60.4)	74 (39.6)
Contact with pesticides by touching plants and crops	96 (51.3)	91 (48.7)
Contact by breathing pesticides in the air	65 (34.8)	122 (65.2)
Contact by being sprayed	23 (12.3)	164 (87.7)
Contact by swallowing sweat off face	29 (15.5)	158 (84.5)
Contact by mixing, loading, or applying pesticides	14 (7.5)	173 (92.5)
Contact by riding on equipment	6 (3.2)	181 (96.8)
Contact by residue on plants	16 (8.5)	171 (91.5)
Drinking water in fields	185 (98.9)	2 (1.1)
Cups available for each worker	176 (94.1)	11 (5.9)
Water to wash hands while working	154 (82.4)	33 (17.7)
Soap for hand washing	110 (58.8)	77 (41.2)
Single use towels	105 (56.5)	81 (43.6)
Washing water separate from drinking water	168 (89.8)	19 (10.2)
Toilet facilities near fields	119 (63.6)	68 (36.4)
Place to shower or bathe after work	177 (94.2)	9 (4.8)
Boss talks to you about pesticide safety	179 (96.2)	7 (3.8)

more likely to use pesticide safety practices when they were told when pesticides were being applied or recently applied (adjusted OR: 4.4, 95% CI: 1.6–11.9). The odds of using pesticide safety practices was 95% lower for farmworkers that reported a place to shower or bathe after work (adjusted OR: 0.05, 95% CI: 0.00–0.58) (Table 3).

Workplace Conditions and Use of Personal Protective Equipment

The odds of using PPE was 3.4 times more likely among farmworkers that reported that water was available for handwashing in the fields while doing agricultural work (adjusted OR: 3.4, 95% CI: 1.3–9.2). Farmworkers that reported that they knew the names of pesticides were 8.4 times more likely to use PPE (adjusted OR: 8.4, 95% CI: 2.7–26.3). Use of PPE was 6.4 times greater among farmworkers that reported they had contact with pesticides by breathing pesticides in the air within the past two weeks while performing agricultural work (adjusted OR: 6.4, 95% CI: 2.3–17.4) (Table 4).

Discussion

The North Carolina Department of Labor requires farmers to meet certain standards for migrant housing related to housing site, structures, kitchens, toilets, laundry and bathing, heating, water and sewer, garbage, pests, and health. Requirements include i) adequate hot and cold running water for bathing and laundry purposes, ii) shower rooms must be equipped to maintain a 70 °C temperature during cold weather, iii) floors must contain drains and must be covered, iv) one showerhead per 10 people, v) one hand wash basin per six people, vi) one laundry tub per 30 people, vii) one slop sink in each building used for laundry, handwashing, and bathing, and viii) a clothes line or clothes dryer must be provided for drying clothes.[28] Although air conditioning is not required under North Carolina Department of Labor Migrant Housing requirements, assessing the risk of pesticide exposure associated air conditioning opens the door to re-evaluate current migrant housing requirements. Therefore, air conditioning was included as a predictor in this study. Migrant labor camps are commonly located down long dirt roads and the houses or trailers are generally located in or near the fields. The risk of pesticide exposure may be increased due to pesticide drift through open windows and doors. One of the objectives of this study was to investigate whether migrant housing in North Carolina is meeting the requirements outlined by the North Carolina Department of Labor for migrant farmworker housing.

Results reported in this study clearly identified several areas of concern regarding farmworker housing and workplace conditions. Study findings on housing conditions indicated that having enough hot and cold water for bathing and doing laundry, availability of air conditioning where the farmworkers slept, and living with relatives and other workers were significant predictors of farmworker use of pesticide safety practices. Significant associations were identified between completion of the seventh grade or higher and one handwashing sink per six people and use of PPE. Several significant associations were also identified between farmworker use of pesticide safety practices and workplace conditions including a place to shower or bathe after work, soap available for handwashing, information about pesticides posted where farmworkers can see it, contact with pesticides by swallowing sweat off face, and told when pesticides are being applied or recently applied. Use of PPE was greater among farmworkers that had access to water to

wash their hands with while working in the fields, knew the names of pesticides, and reported contact with pesticides by breathing pesticides in the air while performing agricultural work. These findings question whether current US EPA WPS and OSHA field regulations in place to reduce pesticide exposure among farmworkers are effective to reduce pesticide exposure among farmworkers. In addition, the Migrant Housing Act of North Carolina, enacted in 1989 which requires growers to register migrant farmworker housing and meet certain standards may be ineffective to ensure that the housing meets the required standards.

Housing conditions were deplorable at several labor camps that were visited during data collection. Based on observations of housing conditions, as the number of workers increase, housing conditions deteriorate rapidly. Several labor camps were trailers and some of the trailers had additions of rooms added that did not have finished walls or floors. One trailer was set on cement blocks, was unlevel, and did not appear to meet county housing codes. Farmworkers work clothes were commonly seen hanging on fencing for pastures and bushes and trees near the labor camps to dry after being washed and may, therefore, have been exposed to pesticide drift. Most of the labor camps had only one bathroom even when more than 11 workers lived in a dwelling. The majority of dwellings did not have air conditioning, the windows were open, and many of these houses were down long dirt roads surrounded by tobacco fields.

Previous studies have reported that migrant labor camps often lack adequate water and toilet facilities, air conditioning, and that overcrowded living conditions affect the farmworkers ability to shower and change out of work clothes in a timely manner.[21-23] However, this study specifically found positive associations between farmworker use of pesticide safety practices and having enough hot and cold water (adjusted OR: 13.6, 95% CI: 1.4–135.4) and availability of air conditioning where the farmworkers slept (adjusted OR: 5.3, 95% CI: 1.5–19.0). Although, air conditioning is not a requirement under the Migrant Housing Act of North Carolina, our study measured whether availability of air conditioning was a significant risk factor for farmworker use of pesticide safety practices. Farmworkers that have access to air conditioning in their living quarters may be more likely to use pesticide safety practices because they have a better understanding of the adverse health effects from pesticide drift through open windows. In a previous study, Early, *et al*,[23] found that lack of air conditioning increased risk of pesticide exposure. The present study provides additional evidence that availability of air conditioning in migrant housing increases farmworker use of pesticide safety practices. Study findings indicated that farmworkers that have access to one handwashing sink per six people and an education level of the seventh grade or higher are more likely to use PPE. Furthermore, results from the present study provide evidence that some North Carolina migrant labor camps are not in compliance with the requirements set forth by the Migrant Housing Act of North Carolina. Findings from the present study support previous study findings that substandard migrant labor camp conditions still exist and impact farmworkers abilities to use pesticide safety practices.

The main study findings on workplace conditions and farmworker use of pesticide safety practices are similar to results reported in previous studies.[16-20] In the present study, participants reported that availability of soap for handwashing was uncommon in the workplace (n=77, 41%). Similarly, Thompson, *et al*,[17] found availability of soap for handwashing (always or

sometimes available [n=228, 60% of the time]) and Vela-Acosta, *et al*,[19] reported that only 29% of farmworkers working for an employer reported soap, towels, and decontamination water was available. In another study among 102 farmworker mothers in Star County, Texas,[18] farmworkers reported that disposable cups, restrooms, toilet paper, soap, water to wash hands, and drying towels were available 12% to 28% of the time. Findings from this study and previous studies point to lack of decontamination and sanitation supplies as a leading factor as to why farmworkers were not using pesticide safety practices. In the present study, there was a significant ($p<0.05$) association between information posted about pesticides where farmworkers can see it and told when pesticides are being applied or recently applied and use of pesticide safety practices. Farmworkers were not told when pesticides were being applied or recently applied (n=33, 17.6%) and more than one-fourth of farmworkers (n=50, 26.6%) reported that information about pesticides was not posted where they could see it. This was not surprising, based on previous study findings. Arcury, *et al*,[20] found that farmers did not perceive pesticide exposure to be dangerous to farmworkers and Stallones, *et al*,[22] identified crop dusting as major concern of pesticide exposure. In the Colorado study[22] one of the participants reported that a crop duster flew over the farmworkers while releasing chemicals that caused many of the workers to "get sick and throw up" and that they were not taken to a clinic for medical treatment. The participant reported that the supervisor had not been informed that the crops were going to be sprayed. These findings reinforce the need to ensure that agricultural employers are posting warning signs when pesticides are being used and also providing oral warnings to workers that they can understand.

Significant associations were found for a place to shower or bathe after work and contact with pesticides by swallowing sweat off the face and farmworker use of pesticide safety practices ($p=0.018$, $p<0.001$, respectively). Educating farmworkers about routes of pesticide exposure and the importance of wearing hats or protective headbands that will absorb sweat on their face must be evaluated as part of pesticide safety training in order to increase use of pesticide safety practices. Although, farmworkers reported a place to shower or bathe after work, housing conditions such as the number of people living in the dwelling compared to the number of bathrooms may account for why the farmworkers did not use pesticide safety practices. In addition, enough hot and cold water may not have been available to shower or bathe after work. Significant associations were found for availability of water to wash hands while working in the fields, contact by breathing pesticides in the air while performing farmwork, and for farmworkers that knew the names of pesticides and use of PPE ($p=0.014$, $p<0.001$, $p<0.001$, respectively).

This study acknowledged several limitations. Self-reported data may have not have been reported accurately by the study participants; however, participants currently working in agriculture were recruited to ensure data integrity and bilingual interviewers were natives of Mexico, ensuring the participants that all their information would be kept private and confidential, and explained to them that the research findings from the study would be used to support healthy and safe working conditions and housing conditions for them. Also, participants in this study were not randomly selected; they were recruited by using a list that included all registered migrant labor camps in North

Carolina. In order to reduce the threat of external validity and minimize overweighting the subgroup selected for this study, participants were chosen throughout four counties in North Carolina, and a maximum of eight participants were recruited in each migrant labor camp. Finally, cause and effect nor a temporal relationship could be established due to the use of a cross-sectional study design.

Despite these limitations, this study revealed several significant housing and workplace risk factors associated with farmworker use of pesticide safety practices. Our findings support the need to continue to investigate whether agricultural employers are providing standard housing and are in compliance with the requirements set forth by the Migrant Housing Act of North Carolina. In addition, our study findings indicate that availability of air conditioning in migrant labor camps should be considered as a requirement under the Migrant Housing Act of North Carolina to reduce pesticide exposure and increase farmworker use of pesticide safety practices.

Poor workplace and housing conditions continue to persist regardless of the US EPA WPS, OSHA field sanitation regulations, and North Carolina Department of Labor Migrant Housing requirements in place to protect farmworkers against the harmful effects of pesticide exposure. Without proper and frequent farm site inspections by the North Carolina Department of Agriculture and agricultural employer compliance with housing and workplace regulations, environmental conditions will continue to negatively influence farmworker use of pesticide safety practices. Further research is needed to determine whether the US EPA WPS, OSHA field regulations, and the Migrant Housing Act of North Carolina guidelines are being enforced, need to be amended, and whether agricultural employers are complying with the requirements.

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