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The association of respiratory symptoms and indoor housing conditions among migrant farmworkers in eastern North Carolina

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Abstract

Farm labor housing has been described as among the worst in the nation, oftentimes with poor and unsanitary, indoor living conditions. The objective of this study was to evaluate the association between indoor environmental risk factors and respiratory health among migrant farmworker occupants ($N=352$) living in employer-provided housing. A cross-sectional sample of adult, Latino male farm laborers were administered a questionnaire to identify the prevalence of major respiratory symptoms. Self-reported and independent observations were made to evaluate

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environmental respiratory risk factors and indoor housing conditions, including but not limited to, the presence of cockroaches, rodents, pesticides, and visible signs of mold. Spirometry was performed to evaluate lung function using FEV₁, FVC and FEV₁/FVC ratio. Bivariate analysis was applied to evaluate associations between respiratory symptoms and selected indoor environmental risk factors. Findings for respiratory health included, prevalence of wheeze (11.4%), coughing up phlegm (17.3%), tightness of chest (16.8%) and runny or stuffy nose (34.4%). Respiratory risks identified inside the dwellings included, the use of pesticides or bug sprays for cockroaches (31.5%), rat or mouse poison (19.5%), visible signs of water damage in the bathroom (22.5%) and mold in the sleeping room (11.1%). Spirometry values were normal for most occupants, although statistically significant associations were found between; mold and coughing up phlegm when not having a cold (p=0.0262); presence of mold and asthma (p=0.0084); pesticides used in the home and tightness of chest (p=0.0001) and, use of tobacco and coughing up phlegm (p=0.0131). Although causal inference can be difficult to establish from a cross sectional study, findings from this study represents suggestive evidence that indoor environmental risk factors may be contributory factors for respiratory health problems among this vulnerable population.

Keywords

Housing; respiratory health; farmworker; environmental health

INTRODUCTION

Migrant farm labor housing is a major source of environmental exposure for which its occupants have little control.^{1,2} Previous research has characterized farmworker housing conditions in the U.S. as being substandard, unsanitary and commonly associated with the presence of rodents, mice, cockroaches, pesticides, environmental tobacco smoke (ETS) and mold.^{2,3-6} In the indoor environment, human exposure to certain biological and chemical factors from manufactured or natural agents can act as risk modifiers that can greatly exacerbate or increase susceptibility to asthma, allergies, and other respiratory illnesses.⁷⁻¹¹ In addition, dampness, mold, insects, rodent infestations, and unsanitary conditions have been shown to contribute to respiratory symptoms and illnesses among occupants.^{2,11,12}

Farmworkers have been described as one of the poorest populations in the U.S., with approximately one-quarter of the workforce earning wages below the national poverty level.³ In North Carolina, nearly all farm labor housing is provided to migrant farmworkers and their families as part of their work compensation by their employer.² Although regulatory standards exist for health and safety of farm labor housing, living conditions are often unfavorable and farmworkers are reluctant to complain due to fear of work-related consequences.¹³ Respiratory symptoms and exposure to indoor environmental risk factors among migrant farmworkers living in employer-provided housing are relatively unknown and warrant further attention.^{2,4}

Each day, migrant farmworkers in the U.S. face significant challenges, including the hazards from living in inadequate housing.⁴ Among the number of limited studies that have

evaluated farmworker housing, poor and inadequate conditions are regularly reported.^{2,4,5,14-16} In a study among farmworkers and housing characteristics in eastern North Carolina, Gentry et al.⁵ described the majority of workers as originating from Mexico, predominantly male, less than 30 years of age with very little education, living in mobile homes, and either renting or receiving free housing from their employer. Among those farmworkers surveyed, substandard housing conditions were consistently reported, including structural defects, leaking roofs, holes in exterior, interior walls and floors, no window screens and the presence of vermin or rodent infestation.⁵ In a separate study of farmworker housing conducted in N.C., Vallejos et al.² found that 89% ($n=168$) of migrant farm labor camps had one or more state regulatory housing inspection violations; 67% were moderately substandard and 22% had severely substandard conditions. The most frequently occurring violations noted included the presence of mold or mildew (63%) and unsanitary kitchens (22%).

Biological or chemical exposure to mold, mold spores, dampness, cockroach, rodent and dust mite allergens, pesticides, chemicals, environmental tobacco smoke (ETS) and unsanitary conditions can have adverse health effects on the human respiratory system. To illustrate, previous studies have linked exposure to mold and mold spores to respiratory health problems, particularly in sensitive individuals, including, upper respiratory tract, cough, wheeze, asthma and allergic symptoms.^{8,17-20} In other studies, dampness in the home has been linked to allergic responses including hay fever and asthma, as well as recurrent headaches, fever, nausea, vomiting, and sore throats.^{19,20} Unsanitary conditions, openings in walls, improperly sealed windows and doors, or lack of window screens of dwellings can provide favorable entry ways and conditions for pest infestations that can lead to the spread of infectious diseases and respiratory viruses.^{19,21,22} Allergic sensitization via cockroach and mouse allergens can be triggering mechanisms for asthma, airway hyper responsiveness (AHR), and wheezing.²³ Other potential indoor respiratory health hazards includes pesticides and household tobacco, which can contribute to chronic phlegm, dry cough, increased wheezing, bronchitis, headache and fatigue.²⁴⁻²⁶

Given the previous research documenting substandard farm labor housing among farmworkers, there has been relatively little published evaluating the respiratory health among occupants living in these unfavorable housing conditions. This study fills a gap in the literature by evaluating indoor environmental risk factors and the association of respiratory health symptoms among farmworkers living in employer-provided housing over one growing season in eastern N.C.

METHODS AND MATERIALS

This study used the community-based participatory research (CBPR) framework to delineate the quality of farmworker housing associated with health. Community partners provided a list of camps and participants were recruited from 16 counties in eastern North Carolina. Initially, a total of 371 farmworkers were recruited in the study; however, complete data were not available for 19 farmworkers, resulting in 352 total participants from 183 camps. Camps were defined as employer-provided housing occupied primarily by unaccompanied male farmworkers, where related or unrelated workers shared living facilities. Dwelling

types of camps included barracks, houses, trailers, apartments, mobile homes, communal residences, or cluster of residences. All farmworkers involved in this project lived in employer-provided housing and gave written consent prior to any data collection. This project received approvals by Wake Forest School of Medicine and East Carolina University, Brody School of Medicine Institutional Review Board.

DATA COLLECTION

Interviews were conducted in Spanish from 352 participants. To reduce the effect of clustering on statistical analysis, one or two farmworkers from each camp were identified and recruited to participate. Farmworkers that completed interviews received \$30 cash incentive. Interviewers for this project were fluent in Spanish and English and received formal interviewer training as part of this project. Self-reported respiratory symptoms data were collected through interviewer-administered questionnaires using the European Community Respiratory Health Survey II Screening (ECRHS II) survey. The questionnaire has been translated and validated in multiple languages, including Spanish.^{27, 28}

Farmworkers were interviewed and asked to self-report respiratory symptoms such as wheeze, cough, and tightness of chest. Lung function tests of participants were performed using the Viasys MicroLoop handheld spirometry system on a laptop computer.

Data on housing conditions were collected using interviewer-administered questionnaires of participants, and by conducting visual housing inspections made by trained study interviewers. The housing conditions questionnaire was structured to assess the presence and absence of pest infestations; pesticides; mold; air conditioner; roof leaks, water damage (from broken pipes, plumbing, etc.) or dampness in the dwelling, and the last time bed sheets were washed. Relative humidity (RH) and temperature data were collected in each dwelling on three separate occasions using the Digital Thermo Hygrometer with DataLogger (calibrated to NIST standards). The hygrometer was calibrated at the beginning of each interview day or as needed to ensure accurate and consistent readings. Readings of RH and temperature were taken in bedrooms and common areas and recorded on the questionnaire as well as stored in the Hygrometer DataLogger memory capacity. During the home inspection, the participants' sleeping areas, kitchen and living room were observed and assessed for moisture and mold. Wall moisture content was verified by using a pinless, moisture meter (Model M254, Tramex Moisture Encounter Plus; Professional Equipment, Janesville, WI) at points 45 cm above the floor in sleeping area and living room or other areas that suggested water problems (e.g., from broken pipes, leaks, heavy rain or flooding). Odors of mildew, must or dampness in dwellings were assessed subjectively by interviewers.

MEASURES

Measures of participant characteristics included: age (18–24, 25–29, 30–39, 40 or more), country of origin, Latino, race, educational attainment (0–6 years, 7–10, or 11+), and H-2A visa status. The number of years of working in agriculture was organized into the following: < 2 years; 2–3 years; 4–7 years; 8 or more years. The type of work activity (planting, cultivating, harvesting, loading, topping tobacco, barning tobacco and other work duty) was

dichotomized. Seasonal occupancy was defined as early (June – mid July), mid (mid July – August) and late (September–October) seasons. Farmworkers current housing type was identified as apartment, single family house, barracks or trailer. The length of time spent living in their current dwelling was categorized as, < 2 weeks, 2–5 weeks; 6–11, and 12 or more weeks. Smoking status was categorized into three groups; never smoked, formerly smoked, or currently smoked.

Measures of self-reported respiratory symptoms were dichotomous for the following; wheezing, or whistling in chest in last 12 months; wheezing/whistling without a cold; woken up with feeling of tightness in chest; woken by shortness of breath; bouts of coughing, and coughed up phlegm when not having a cold. Measures for allergies included: runny or stuffy nose; sinusitis or sinus problem; asthma; nasal allergies, and eczema or any kind of skin allergy. Objective measures of lung function were obtained for each participant using spirometry, and evaluated using the Forced Expiratory Volume in 1 second (FEV₁), Forced Vital Capacity (FVC), and the FEV₁/FVC ratio. The percent of predicted values were based on the NHANES III data set reference and the FEV₁/FVC ratio.³⁰ The following categories of indoor conditions were included as part of the environmental exposure assessment: pest infestation, use of pesticides, mold and moisture, air conditioning unit, and smoking inside the dwelling. Pest infestations that were self-reported by occupants included the dichotomous measures of the presence of cockroaches, rats or mice in sleeping rooms and kitchen areas. Additional observations were made by study interviewers in the sleeping room for the presence of live or dead cockroaches and rodents, excrement, cockroach egg casings and rodent holes. Pesticides were self-reported by farmworker occupants and included the presence of insecticides or bug sprays for cockroaches, rat or mice poisons in sleeping or kitchen areas. Moisture, mold and mildew were assessed by interviewers and included the presence of leaks, mold, water damage and odors of mildew in the sleeping room as well as visible signs of water damage in the bathroom. The presence (or absence) of an air conditioning unit in the sleeping room was also noted. The last time bed sheets were washed was characterized by four values; 5 days, 6–10 days ago, 11–28 days ago and more than 4 weeks ago. The number of participants that indicated that someone staying in their house smoked cigarettes inside the home was also reported.

Additional outcome measures, noted as “violations”, were evaluated. These dichotomous violations determine whether housing conditions were in compliance with the N.C. Department of Labor (NCDOL) Migrant Housing (camps) Standards Checklist.²⁹ Housing violation outcome measures were developed using an aggregated violations method technique that has been previously described in an earlier study.⁶ Housing violation measures were as follows; cockroach infestation in the sleeping room; rodent infestation in the sleeping room; pesticide use in the home; presence of mold, water damage in sleeping room; and number of people in sleeping room.

ANALYSIS

For all 352 participants, descriptive statistics (count, percent or mean, standard deviation as appropriate) were calculated for participant characteristics of interest, environmental risk factors, self-reported respiratory symptoms, and spirometry results. The Pearson Chi-square

test or Fischer's exact test was performed as appropriate to evaluate the association between self-reported respiratory symptoms and various indoor environmental risk factors. Self-reported respiratory symptoms included wheezing or whistling in chest in last 12 months, woken up with feeling of tightness in chest, coughing up phlegm and allergies (stuffy/runny nose and asthma). Indoor environmental risk factors that were identified as housing violations included; cockroach infestation in the sleeping room; rodent infestation in the sleeping room; pesticide use in the home; presence of mold, water damage in sleeping room; and number of people in sleeping room.

Other indoor environmental risk factors identified through self-reported and observations included, more than 4 weeks since last time bed sheets were washed; smoking inside the house; seasonal occupancy (early, mid or late season), work activities (planting or cultivating, harvesting or topping, loading or barning), and smoking status. Statistical significance was considered of P -values <0.05 . Data analysis was performed using SAS v9.3 (SAS, Cary, NC).

RESULTS

Demographic characteristics of 352 participants in 183 camps are summarized in Table 1. The average age of participants was 33 years (SD 10.16). Almost all farmworkers originated from Mexico (95.2%), reported being Latino (98.0%) and mixed race (95.0%). Almost half had 6 or less years of education (48.6%) and over one-third reported 8 or more years of working in agriculture (37.2%). Approximately sixty-five percent reported having H-2A visas. Participants work duties included; planting (4.8%), cultivating (2.8%), harvesting (58.2%), loading (12.5%), topping (39.2%) and barning tobacco (19.0%) and other miscellaneous work tasks (6.5%). Forty-two percent of farmworkers reported currently living in barracks; almost half (48.3%) resided in their dwelling 12 or more weeks out of the year. Thirty six percent of participants reported having never smoked, 28% as former smokers and 36% as current smokers.

ENVIRONMENTAL RISK FACTORS AND HOUSING CONDITIONS

As shown in Table 2, twenty-two percent of participants reported the presence of cockroaches in the sleeping room and 28% in the kitchen within the last week. Rats or mice were self-reported by farmworker occupants in 18.2% of sleeping rooms and 24.8% in kitchen areas. Cockroach excrement was observed in 24.6% of the sleeping rooms; live or dead roaches were observed in 19.4% of the sleeping rooms. Rodent excrement was identified in 17.1% of the sleeping rooms and rodents were present in 4.3% of the sleeping rooms. Pesticides (insecticides or bug sprays) being used in the home for controlling cockroaches was reported by 31.5% of participants. The use of rat or mice poison was reported in 19.5% of dwellings; 68.2% in sleeping rooms and in 80.3% of kitchens. For moisture, leaks were observed in 4.9% of sleeping rooms; mold was observed in 11.1% of the sleeping rooms and visible signs of water damage in 22.5% of bathrooms. Water leaks or dampness from broken pipes, leaks or heavy rain or floods was observed in 5.4% of sleeping rooms. Mildew or musty odors were present in 10.5% of the sleeping rooms. Overall, 58.8% of farmworker housing had no air conditioning in the sleeping room, with average indoor

temperatures of 83.3°F in sleeping areas and 85.2°F in common areas (temperature data not shown). Approximately 22% of the participants reported washing of bed sheets within the past 5 days; 41% of the participants reported washing of bed sheets within the past 6–10 days, 25% between 11–28 days; and 13% reported more than 4 weeks ago. Smoking inside the home was reported by 20.5% of participants. The mean relative humidity identified in sleeping areas was 60.2% (RH), and 62.2% (RH) in common areas (not shown).

RESPIRATORY HEALTH AND SPIROMETRY

The prevalence of self-reported respiratory symptoms among participants (Table 3) included; wheezing (11.4%), wheezing/whistling without a cold (60.0%), woken with tightness in chest (16.8%), shortness of breath (14.0%), bouts of spasms of coughing either not at all or at least once in the last 12 months (97.4%), and coughed up phlegm when not having a cold (17.3%). Self-reported allergies included, runny or stuffy nose (34.4%), sinus problems (12.2%), asthma (3.4%), nasal allergies (16.5%), and eczema or any kind of skin allergy (22.4%).

In spirometry tests (results not shown) less than 5.0% ($n=16$) of participants had mean FEV₁ results that were outside the normal range of predicted values ($M=3.91$, $SD=0.69$). The FEV₁/FVC ratio for all participants were within normal of the predicted value of greater than 70 percent ($M=82.90$, $SD=2.22$). At the time of data collection, our instruments did not report Lower Limit of Normal (LLN), so the previous ATS standard of 70% was used. All of the participants were able to properly perform the tests and those that had outside normal values were counseled and asked to seek health care provider follow-up.

As shown in Table 4, bivariate analysis detected statistical significance among the following; pesticides used in the home and reported tightness of chest ($p=0.0001$); where 26% of those who had pesticide use in the home also had tightness of chest, compared to 10% reporting not having pesticides used in the home and having tightness in chest; Twenty-six percent who had the presence of mold in the sleeping room and coughing up phlegm ($p=0.0262$), versus only 15% of those who did not have a mold presence and coughing up phlegm; reported asthma and the presence of mold ($p=0.0084$), where 9% of those who had mold in the sleeping room had asthma, compared to only 2% of those who did not have mold presence and had asthma, and finally; smoking status and coughing up phlegm, where 21%–22% of current and former smokers had coughed up phlegm in the past 12 months versus 9% of never smokers had coughed up phlegm ($p=0.0131$). Although not quite statistically significant, 22% of those with a cockroach violation in the sleeping room also had tightness in their chest, compared to only 14% reporting tightness in chest without a cockroach violation ($p=0.0546$). Also, not statistically significant, but worth noting was the percent of farmworkers that harvested or topped tobacco were more likely to report wheeze (12%), tightness in chest (18%), runny/stuffy nose (35%), coughing up phlegm (19%) and asthma (4%) than those not harvesting or topping tobacco.

DISCUSSION

The respiratory system is the most common site of injury for exposure to biological and chemical airborne pollutants and can result in negative health impacts to occupants in the indoor environment.³¹ The findings presented in this study identify that a large proportion of farm labor housing in eastern N.C. have numerous indoor risk factors, including mold, mildew, pesticides, cockroaches, rodents and excrement that could potentially contribute to adverse respiratory health symptoms to farmworker occupants. From this study, the trending prevalence of self-reported cough, phlegm and tightness of chest present hallmark characteristics that signify concern for further medical respiratory evaluation. The statistically significant relationships found between the presence of mold and coughing up phlegm, pesticides and tightness of chest are indicators that warrant further, more in-depth investigation. A small group of participants appeared to have positive spirometric screen for obstructive lung disease; however, 5% is consistent with previously epidemiologically reported prevalence of asthma in the Mexican and Mexican-American populations.³² Although, there are relatively few published respiratory farmworker studies available, the estimate we obtained for wheeze (11.4%) appeared comparable yet, shortness of breath (14%), tightness in chest (16.8%) and coughing up phlegm (17.3%) were higher in these findings than those found elsewhere in the literature. From the limited studies identified, Mirabelli et al.,³³ reported increases in wheezing or whistling in chest (4–21%), woken by shortness of breath (4–8%) and reporting of runny or stuffy nose (8–12%) across an agricultural season in a study of job activities and respiratory symptoms among farmworkers. In an earlier respiratory study (1996) among Midwest Hispanic (male) farmworkers, Garcia et al.,³⁴ documented the crude prevalence of wheeze (5.8%), chronic cough (8.5%) and coughing up phlegm (8.0%). Although these differences are noted, accurate comparisons are difficult to assess from cross sectional studies and further examination using different study designs such as case-control or cohort may provide more insight for evaluating these effects. Nevertheless, the associated observed housing conditions identified here provide evidence that the existence of these indoor environmental risk factors exist and are sufficient to negatively impact respiratory health.

Farmworkers are a poor and vulnerable population that face many challenges,³⁵ including having little control over their living conditions. Environmental risk factors associated with poor housing quality in the indoor environment can pose serious respiratory adverse health risks,³⁶ particularly for farmworker families with infants and small children that live in these conditions. Adequate and decent housing is “a basic human right”³⁷ and conditions associated with housing are determinants of health. Farmworkers contribute significantly to the agricultural production workforce sector in the U.S. and improving housing conditions among farmworkers should be a priority by their employers. Recently, the USDA announced low interest loans available to farmers, non-profits, associations of farmworkers and others to “build, buy, improve or repair farm labor housing.”³⁸ This opportunity appears to symbolize and acknowledge the need towards improving housing conditions among farmworkers and their families.

This study was met with limitations. Although statistically significant associations were evidenced in this study, additional behavioral and clinical information of participants are

needed to confirm any true associations. Characterizing accurate exposure data particularly among migrant farmworkers can be problematic and met with significant epidemiologic challenges.^{39,40} Time spent indoors versus outdoors, working conditions, personal behaviors, diet and genetics, self-reporting bias are all confounding factors that were not included in this evaluation. Also, a large percentage (37%) of farmworkers had more than 8 years of work experience in agriculture and 27% were between the ages of 18–24 years, which may have contributed to the healthy worker effect and accounted for the large percentage of normal values of pulmonary function tests. Also, because a small number of farmworkers from each camp participated and performed respiratory assessments, these results may not be representative of all farmworkers living in camps. Therefore, caution should be used when interpreting the findings of this study. Logistics of this type of CRBPR precluded more definitive pulmonary function testing with bronchoprovocation which would allow us to detect subjects with asthma who were asymptomatic at the time of testing. Other limitations include that most (95.2%) farmworkers were from Mexico and 65% held H-2A visas and may have had pre-existing respiratory conditions or other environmental or occupational exposures prior to participating in this study.

In light of these challenges, this study fills a gap in the literature as a preliminary investigation for evaluating indoor housing conditions and environmental respiratory risk factors among Latino farmworkers. A study of this nature could be expanded upon to include other factors including, occupational history, clinical and behavioral aspects, bronchoprovocation testing, induced sputum (to identify eosinophilia or neutrophilia which are commonly seen in atopic and inflammatory lung disease), over a longer study period. Future indoor housing and respiratory exposure studies should include Latino farmworker families, particularly children and women of child-bearing age who are at increased risks. Establishing causal links between farmworker housing and respiratory health can prove difficult; nonetheless, substandard living conditions, safety and health hazards are well documented and serve as significant public health indicators that should not be ignored.

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Table 1

Description of migrant farmworker participants in eastern North Carolina (n=352)

Participant Characteristic	n (%)
Age in years: Mean (SD) [range]	32.58 (10.16) [48]
18 to 24 years	94 (26.7)
25 to 29 years	62 (17.6)
30 to 39 years	105 (29.8)
40 or more years	91 (25.9)
Country of origin	
Mexico	335 (95.2)
Other	17 (4.8)
Latino*	
No	7 (2.0)
Yes	339 (98.0)
Race*	
White	8 (2.3)
American Indian or Alaska Native	1 (0.3)
Other	8 (2.3)
Mixed	326 (95.0)
Educational attainment	
0–6 years	171 (48.6)
7–10 years	131 (37.2)
11 or more years	50 (14.2)
H-2A visa status	
Non-H-2A	124 (35.2)
H-2A	228 (64.8)
Years in agriculture	
Less than 2 years	39 (11.1)
2–3 years	85 (24.1)
4–7 years	97 (27.6)
8 or more years	131 (37.2)
Work task ⁺	
Planting	17 (4.8)
Cultivating	10 (2.8)
Harvesting	205 (58.2)
Loading*	44 (12.5)
Topping Tobacco	138 (39.2)
Barning Tobacco	67 (19.0)
Other	23 (6.5)
Seasonal occupancy	
Early	96 (27.3)

Participant Characteristic	n (%)
Mid	161 (45.7)
Late	95 (27.0)
Where do you live	
Apartment	4 (1.1)
House	104 (29.5)
Barracks	147 (41.8)
Trailer	97 (27.6)
Length in dwelling	
Less than 2 weeks	20 (5.7)
2 weeks to less than 6 weeks	56 (15.9)
6 weeks to less than 12 weeks	106 (30.1)
12 weeks or more	170 (48.3)
Smoking status	
Never	127 (36.1)
Former	98 (27.8)
Current	127 (36.1)

* missing values

+ more than one work task allowed

Table 2

Indoor environmental risk factors and living conditions of farmworker housing

Environmental Risk Factor	n (%)
Pest infestation (self-reported by occupant)*	
Cockroaches present in sleeping room in last week	77 (21.9)
Cockroaches present in kitchen within the last week	98 (28.2)
Rats or mice present in sleeping room	64 (18.2)
Rats or mice present in kitchen	87 (24.8)
Pest infestation (observed by interviewer)*	
Cockroach excrement present in sleeping room	85 (24.6)
Live/dead roaches present in sleeping room	67 (19.4)
Cockroach egg cases present in sleeping room	46 (13.4)
Rodent excrement present in sleeping room	59 (17.1)
Live/dead rodent present in sleeping room	15 (4.3)
Rodent holes present in sleeping room	21 (6.1)
Pesticides (self-reported by occupant)*	
Insecticides or bug sprays used in house for cockroaches	109 (31.5)
Rat poison used in home for rats or mice	67 (19.5)
If yes, rat poison used in sleeping room	45 (68.2)
If yes, rat poison used in kitchen	53 (80.3)
Mold and Moisture (observed by interviewer)*	
Water leaks in sleeping room	17 (4.9)
Mold in sleeping room	39 (11.1)
Visible signs of water damage present in bathroom	78 (22.5)
Any water or dampness from broken pipes leaks heavy rain or floods in sleeping room	19 (5.4)
Mildew or musty odor in sleeping room	37 (10.5)
Presence of Air Conditioning	
Sleeping room	145 (41.2)
Last time bed sheets were washed*	
Within the past 5 days	70 (21.6)
6–10 days ago	40.7 (132)
11–28 days (4 weeks)	24.7 (80)
More than 4 weeks	13.0 (42)
Anyone smoke inside the home (self-reported by occupant)*	69 (20.5)

* missing values for category

Table 3

Prevalence of self-reported respiratory symptoms and allergies among farmworkers (n=352)

Respiratory Symptom	n (%)
Wheezing or whistling in chest in last 12 months *	40 (11.4)
If yes, wheezing/whistling without a cold	24 (60.0)
Woken up with feeling of tightness in chest	59 (16.8)
Woken by shortness of breath *	49 (14.0)
Bouts of spasms of coughing *	
Not at all	301 (85.7)
Less than once a month	41 (11.7)
Between once a month and once a week	6 (1.70)
Between once a month and once a day	1 (0.30)
Once a day or more	2 (0.60)
Coughed up phlegm when you did not have a cold	61 (17.3)
Allergy	
Runny or stuffy nose	121 (34.4)
Sinusitis or sinus problem *	42 (12.2)
Asthma *	12 (3.4)
If yes, confirmed asthma by doctor *	9 (81.8)
Nasal allergies *	57 (16.5)
Eczema or any kind of skin allergy *	78 (22.4)

* missing values

Table 4

Bi-variate associations of housing conditions and respiratory symptoms among farmworker occupants

Factors	Wheeze			Tightness Chest			Runny/Stuffy Nose			Coughed up phlegm			Asthma		
	No = 311	Yes = 40	p-value	No = 293	Yes = 59	p-value	No = 231	Yes = 121	p-value	No = 291	Yes = 61	p-value	No = 338	Yes = 12	p-value
Housing															
Cockroach infestation in + sleeping room (violation)	No	193(88.94)	24(11.06)	188(86.24)	30(13.76)	NS	148(67.89)	70(32.11)	NS	183(83.94)	35(16.06)	NS	210(96.77)	7(3.23)	NS
	Yes	118(88.06)	16(11.94)	105(78.36)	29(21.64)		83(61.94)	51(38.06)		108(80.6)	26(19.4)		128(96.24)	5(3.76)	
Rodent infestation in sleeping room (violation) +	No	229(88.42)	30(11.58)	222(85.38)	38(14.62)	NS	177(68.08)	83(31.92)	NS	217(83.46)	43(16.54)	NS	248(96.12)	10(3.88)	NS
	Yes	82(89.13)	10(10.87)	71(77.17)	21(22.83)		54(58.7)	38(41.3)		74(80.43)	18(19.57)		90(97.83)	2(2.17)	
Pesticide use in home +	No	183(89.27)	22(10.73)	185(89.81)	21(10.19)	0.0001	140(67.96)	66(32.04)	NS	171(83.01)	35(16.99)	NS	201(98.05)	4(1.95)	NS
	Yes	121(87.68)	17(12.32)	102(73.91)	36(26.09)		85(61.59)	53(38.41)		114(82.61)	24(17.39)		129(94.16)	8(5.84)	
Presence of mold, water damage sleeping room +	No	233(88.59)	30(11.41)	221(83.71)	43(16.29)	NS	176(66.67)	88(33.33)	NS	224(84.85)	40(15.15)	0.0262	258(98.1)	5(1.9)	0.0084
	Yes	72(88.89)	9(11.11)	65(80.25)	16(19.75)		48(59.26)	33(40.74)		60(74.07)	21(25.93)		73(91.25)	7(8.75)	
More than 4 weeks since bed sheets were washed	No	248(88.26)	33(11.74)	234(82.98)	48(17.02)	NS	186(65.96)	96(34.04)	NS	231(81.91)	51(18.09)	NS	272(97.14)	8(2.86)	NS
	Yes	37(88.1)	5(11.9)	36(85.71)	6(14.29)		25(59.52)	17(40.48)		38(90.48)	4(9.52)		39(92.86)	3(7.14)	
Number of people in sleeping room (violation) +	No	266(88.67)	34(11.33)	252(83.72)	49(16.28)	NS	195(64.78)	106(35.22)	NS	253(84.05)	48(15.95)	NS	288(96.32)	11(3.68)	NS
	Yes	40(86.96)	6(13.04)	37(80.43)	9(19.57)		33(71.74)	13(28.26)		34(73.91)	12(26.09)		46(100)	0(0)	
Seasonal occupancy	Early	84(88.42)	11(11.58)	83(86.46)	13(13.54)	NS	59(61.46)	37(38.54)	NS	78(81.25)	18(18.75)	NS	95(98.96)	1(1.04)	NS
	Mid	146(90.68)	15(9.32)	134(83.23)	27(16.77)		110(68.32)	51(31.68)		139(86.34)	22(13.66)		152(95.6)	7(4.4)	
	Late	81(85.26)	14(14.74)	76(80.0)	19(20.0)		62(65.26)	33(34.74)		74(77.89)	21(22.11)		91(95.79)	4(4.21)	
Smoking inside the house	No	239(89.51)	28(10.49)	224(83.58)	44(16.42)	NS	174(64.93)	94(35.07)	NS	224(83.58)	44(16.42)	NS	259(97)	8(3.0)	NS
	Yes	61(88.41)	8(11.59)	55(79.71)	14(20.29)		46(66.67)	23(33.33)		54(78.26)	15(21.74)		64(94.12)	4(5.88)	
Work behavior															
Planting or Cultivating	No	286(87.73)	40(12.27)	272(83.18)	55(16.82)	NS	213(65.14)	114(34.86)	NS	272(83.18)	55(16.82)	NS	314(96.62)	11(3.38)	NS
	Yes	25(100)	0(0)	21(84)	4(16.0)		18(72)	7(28.0)		19(76)	6(24.0)		24(96)	1(4.0)	
Harvesting or Topping	No	53(92.98)	4(7.02)	50(87.72)	7(12.28)	NS	38(66.67)	19(33.33)	NS	51(89.47)	6(10.53)	NS	56(98.25)	1(1.75)	NS
	Yes	258(87.76)	36(12.24)	243(82.37)	52(17.63)		193(65.42)	102(34.58)		240(81.36)	55(18.64)		282(96.25)	11(3.75)	
Loading or Burning	No	237(88.76)	30(11.24)	221(82.77)	46(17.23)	NS	179(67.04)	88(32.96)	NS	225(84.27)	42(15.73)	NS	258(97.36)	7(2.64)	NS
	Yes	73(87.95)	10(12.05)	71(84.52)	13(15.48)		51(60.71)	33(39.29)		65(77.38)	19(22.62)		79(94.05)	5(5.95)	
Non-Working behavior															
Tobacco Use (cigarettes)	Current	111(87.4)	16(12.6)	104(81.89)	23(18.11)	NS	82(64.57)	45(35.43)	NS	100(78.74)	27(21.26)	0.0131	121(95.28)	6(4.72)	NS

Factors	Wheeze		Tightness Chest		Runny/Stuffy Nose		Coughed up phlegm		Asthma	
	No = 311	Yes = 40	No = 293	Yes = 59	No = 231	Yes = 121	No = 291	Yes = 61	No = 338	Yes = 12
Former	88(89.8)	10(10.2)	77(78.57)	21(21.43)	63(64.29)	35(35.71)	76(77.55)	22(22.45)	92(95.83)	4(4.17)
Never	112(88.89)	14(11.11)	112(88.19)	15(11.81)	86(67.72)	41(32.28)	115(90.55)	12(9.45)	125(98.43)	2(1.57)

NS= p > 0.05

⁺ Aggregated housing violatio