

Farmworker Housing in the United States and Its Impact on Health

Sara A. Quandt¹, Carol Brooke²,
Kathleen Fagan³, Allyson Howe⁴,
Thomas K. Thornburg⁴, and
Stephen A. McCurdy⁵

NEW SOLUTIONS: A Journal of
Environmental and Occupational
Health Policy
2015, Vol. 25(3) 263–286
© The Author(s) 2015
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/10482911155601053
new.sagepub.com



Abstract

Farmworkers in the United States occupy a range of housing, including both on- and off-farm family and communal dwellings. As the farmworker population is becoming more settled, housing needs are changing. Existing regulations designed originally for grower-supplied migrant housing may need to be expanded. Much of farmworker housing is in poor condition, and likely linked to negative mental and physical health outcomes of residents because of exposures to crowding; mold, mildew, and other allergens; pesticides; and structural deficiencies. The existing research literature, both on housing conditions and their associations with farmworker health, is sparse, and large areas of the country and significant domains of health are omitted. This paper reviews this literature and formulates research and policy recommendations for addressing these deficiencies.

Keywords

environmental health, migrant labor, housing

¹Wake Forest School of Medicine, Department of Epidemiology and Prevention, Medical Center Boulevard, Winston-Salem, NC, USA

²North Carolina Justice Center, Raleigh, NC, USA

³Occupational Safety and Health Administration, Washington, DC, USA

⁴Farmworker Legal Services, Kalamazoo, MI, USA

⁵School of Medicine, University of California, Department of Public Health Sciences, Davis, CA, USA

Corresponding Author:

Sara A. Quandt, Wake Forest School of Medicine, Department of Epidemiology and Prevention, Medical Center Boulevard, Winston-Salem, NC 27157, USA.

Email: squandt@wakehealth.edu

Introduction

Farmworkers constitute one of the few remaining occupational groups whose housing may be tied directly to employment, as many live in grower-provided housing and still others live close to the rural worksite. Although farmworker housing should meet local standards (and for migrant workers, those set by the Migrant and Seasonal Agricultural Worker Protection Act of 1983, 29 U.S.C. §§ 1801–1972), historically, it has not.¹

An extensive environmental health literature documents the deleterious effects of poor housing conditions on residents.^{2,3} Exposures including chemicals (e.g., lead and pesticides), allergens, pests, and moisture lead to negative respiratory, dermatologic, and neurobehavioral outcomes.^{4–6} Social exposures such as crowding and noise have been linked to negative behavioral and mental health outcomes.⁷

Despite evidence of poor-quality housing for farmworkers and of a linkage between housing and health in the general population, there have been relatively few attempts to unite these two bodies of research to examine the impact of farmworker housing on the health status of residents. Because farmworkers are already at substantial physical risk by virtue of working in agriculture,^{8,9} exposures from housing could place their health in additional jeopardy.

This paper reviews the literature examining the link between housing conditions experienced while working in the United States and farmworker health. The goals are to (1) describe the state of current farmworker housing, based on data from peer-reviewed, government, and other available documents; and (2) review published evidence for health effects linked to housing exposures.

The Current State of Farmworker Housing

The most recent published report describing the housing status of the nation's farmworkers is based on the 2005–2007 Current Population Survey (CPS) conducted by the Bureau of Labor Statistics.¹⁰ This nationally valid, cross-sectional sample distinguished for the first time the housing status of noncitizen farmworkers (including crop and livestock workers) from that of citizen workers (Table 1). Hired managers and foremen were included in this sample.

The CPS sample of farmworker households demonstrates that many share their dwellings with nonfamily members. Just over half reside in a dwelling owned by them or a member of their family. The typical dwelling is a house or apartment. One out of seven households lives in a mobile home, trailer, or other type of dwelling.

The extent of shared living quarters is greatest among *noncitizen workers*, averaging 1.8 families and 4.7 persons per dwelling compared with 1.2 families and 3.4 persons among citizen workers. Only 24% of noncitizen farmworkers reside in a dwelling owned by them or by a member of their immediate family.

Table 1. Household and Housing Characteristics, Hired Farmworkers in the United States, 2005–2007.^a

Characteristic	Noncitizen	Citizen	Total
Household composition			
Persons per household (mean)	4.7	3.4	3.9
Families per household (mean)	1.8	1.2	1.4
Housing tenure (%)			
Own dwelling	24.0	69.2	52.6
Rent dwelling	61.8	17.6	33.9
Noncash rental	12.7	12.5	12.6
Public housing	1.4	0.7	0.9
Housing type (%)			
House or apartment	80.6	88.7	85.7
Mobile home, trailer, other	19.4	11.3	14.3

^aData from Kandel, 2008.¹⁰

Nearly one in five noncitizen workers resides in a mobile home, trailer, or other, most likely temporary, quarters.

The National Agricultural Worker Survey of the U.S. Department of Labor (NAWS) is the only source of information about the status of farmworker housing for a national sample, focused solely on farmworkers. The NAWS conducts face-to-face interviews with a valid national cross-sectional sample of employed crop workers. The most recent published report from the NAWS that discusses housing was based on 6472 worker interviews conducted between 1 October 2000 and 30 September 2002.¹¹ It is now somewhat dated.

In the NAWS report, 58% of respondents rented their dwelling from someone other than their employer, 19% lived in a dwelling they or a family member owned, 17% resided in housing provided free by their employer, 4% rented housing from their employer, and 2% lived rent-free with family or friends. In an earlier comparable NAWS survey (1993–1994), only 43% rented from nonemployers and 33% lived in employer-provided housing.

The 2000–2002 NAWS survey also found that 55% of respondents resided in some type of single-family dwelling or unit, 22% lived in an apartment, 16% lived in a trailer or mobile home, and 7% lived in other types of housing, including dormitories, barracks, multifamily structures, motels, or hotels. About 14% of crop workers lived on a farm during 2000–2002, compared with 24% in the 1993–1994 survey.

The NAWS surveys indicate that fewer crop workers now reside on a farm or in employer-provided housing (19% in 2000–2002 vs. 33% in 1992–1994). The findings are consistent with those from the 2005–2007 CPS sample shown

in Table 1. The NAWS does not include measures of participants' health or housing quality. Thus, the NAWS, like the CPS, is limited in its ability to describe the relationship of farm labor housing to the health of occupants.

The most recent NAWS findings, based on interviews conducted during 2010–2012, indicate 79% of all U.S. hired crop workers were settled, living permanently in the United States with their family members.¹² This is a substantial increase from NAWS findings in 2005–2007, when 67% of workers were settled.¹³ The 2010–2012 NAWS findings indicate that 6% of respondents were follow-the-crop migrant workers, 14% were shuttle migrants (i.e., workers who travel at least 75 miles to work within 75 miles of a fixed location in the United States and return home at the end of the season), and only 2% were newly arrived migrants from Mexico or Central America. These trends suggest that farmworkers will increasingly find housing in local housing markets rather than on a farm.

Farmworker Housing: Measures of Housing Quality

Crowded Dwellings

Numerous studies of farmworker housing report crowded or extremely crowded conditions.^{14–17} In a national convenience sample of purposefully selected farmworker housing, using a crowding definition of more than one person per room (excluding bathrooms), 52% of all units were crowded. Among crowded units, 74% included children.¹⁴

A recent study of farm labor housing in Napa County, California, asked about the physical condition of housing.¹⁸ Three-fourths of participants responded to a query concerning problems with their current housing. The most frequent complaint was crowded conditions, followed by “cold and/or drafty; not enough heat” and “missing or torn window screen.”

The California Agricultural Worker Health Survey (CAWHS),¹⁹ a population-based survey of hired farmworkers conducted in 1999, was a multi-stage household sample and included detailed queries about housing arrangements. Respondents were asked to report the number of persons who slept in the dwelling and the number of rooms in the dwelling. The highest number of persons residing in a single dwelling was seventeen, in a five-room structure. Overall, 227 dwellings (25% of the total number of dwellings) had six or more residents. Of the 3842 persons enumerated, only fifty-six lived alone. The reported average number of residents per dwelling was 4.33.¹⁷

“Crowding” is described as corresponding to an average occupancy of 1.01 or more persons per room.²⁰ By this measure, 48% of all dwellings in the CAWS survey were “crowded” and 25% were “extremely crowded” (1.51 or more persons per room). By contrast, in the 2009 American Housing Survey, 1.9% of dwellings were crowded and 0.3% were extremely crowded.²¹

In the CAWHS survey, 42% of dwellings were shared by two or more unrelated households, but this figure varied greatly from site to site. In Vista, California, 87% of dwellings had families “doubling up.” Shared dwellings could not be simply characterized. In some instances, sharing arrangements involved groups of unaccompanied men. In other cases, two or more families, including spouses and children, were present in a dwelling. Sometimes a “primary” renter sub-leased a room, or a bed, to help meet rental costs; this arrangement partly accounted for the large proportion of shared dwellings reported.

A study that included a large convenience sample of farm labor housing units in Washington State did not directly determine the number of persons per room used for sleeping.²² However, the authors estimated that 32% of workers in the survey resided in a crowded dwelling.

Researchers in North Carolina also found substandard conditions to be common in migrant housing and to vary across the season.²³ In 2007 and 2008, researchers collected data via interviewer-administered questionnaires to farmworkers living in forty-three randomly selected farmworker camps. The lack of adequate facilities for the number of people living within the camp was an indicator of overcrowding.²³ The researchers concluded that 78% of camps had one or more residents who felt their living conditions were overcrowded, and that, depending on the time of the season, between 26% and 31% of the camps had less than the required minimum area (50 square feet) per person in a sleeping room. This study also noted the importance of having access to enough washing machines; pesticide residues frequently contaminate farmworkers’ clothing, and many farmworkers have only a limited amount of clothing. Between 4% and 28% of the camps were in violation of the North Carolina health and safety standard that requires one washtub or washing machine for every thirty residents.²³

A subsequent survey of 186 North Carolina farmworker camps assessed workers’ perceptions of crowding.²⁴ Almost three-quarters reported insufficient personal storage space, and one-quarter reported insufficient kitchen storage and refrigerator space. In addition, 12.9% of workers interviewed had less than the required 50 square feet for sleeping room area.²⁵ In fact, 13.2% shared a bed with another worker, and 50.4% slept in the dwelling’s common room instead of a bedroom.

Structural Deficiencies

In the few studies that have examined the physical condition of farmworker housing, structural deficiencies are prevalent.^{14–16,26–28} These include holes in exterior walls, broken plumbing, broken screens, leaky roofs, nonfunctional air conditioning or heating systems, and unsafe drinking water, among other conditions.

In the CAWHS survey, 4.4% of dwellings lacked plumbing, and 3.8% lacked food preparation facilities. Some 20% were entirely without telephone service.

The absence of plumbing or kitchen facilities was associated with the type of dwelling—1% of permanent structures lacked such facilities, but 17% of informal or labor camp structures did not have either or both of these facilities. All vehicles used as dwellings lacked both plumbing and kitchen facilities.

Some 35% of hired farmworkers interviewed in the Washington State convenience sample reported housing problems: 27% reported peeling, cracking, or chipped paint; 17% had heating or plumbing problems or lacked heat, 16% had electrical problems, 15% had holes in the floor or walls, 13% reported drafts through holes or windows, 12% had leaking ceilings, and 4% lacked plumbing and/or a toilet.²²

Researchers in North Carolina have published extensive studies on various aspects of farmworker housing in that state. They have examined housing characteristics¹⁵; safety, security, and privacy²⁴; housing conditions²³; field and camp safety²⁹; pesticide exposure³⁰; heat index³¹; and housing quality.¹⁶ In one study, 74% of dwellings had structural damage.²⁶ Studies in 2007 and 2008 of migrant farmworker housing conditions during the agricultural season in North Carolina found that only 11% of the farmworker camps examined met state housing standards. Over one-fifth (22%) were severely substandard (e.g., had a major plumbing problem such as no working toilet, or had eight or more interior or exterior problems, or had both electrical and structural hazards), and 67% were moderately substandard (e.g., had one or more minor plumbing problems, had two to seven interior or exterior problems, or had either electrical or structural hazards).²³ Camps inhabited by women and children were more likely to be substandard, along with camps that housed at least one speaker of an indigenous language. Camps without farmworkers who held guest worker (H-2A) visas were also more likely to be in substandard condition²³ (see <http://www.uscis.gov/working-united-states/temporary-workers/h-2a-agricultural-workers/h-2a-temporary-agricultural-workers>). In another survey of 183 farmworker camps, housing regulation violations were common across all domains—sleeping rooms, bathrooms, laundry, and general housing violations.²⁶ The mean number of violations was 11.4 of sixty-three possible violations.

Pest Infestations

Studies regarding pest infestations in farm labor housing found numerous instances of such conditions.^{4,26} Rodents and cockroaches were the most prevalent pests encountered by residents.

Exposure to Agricultural Chemicals

Numerous reports have discussed farmworkers' exposure to agricultural chemicals. Most such studies find evidence of pesticides in or about the home, often in rugs or furnishings, and often attributable to contaminated work clothing being

brought home. Researchers in the Salinas Valley of California measured pesticide exposure in the homes of pregnant women in a farmworker community, and urinary metabolites of chemicals widely used in agricultural production in women and their children.^{4,32} Earlier studies in Washington State had found evidence of pesticide contamination in homes located near farm land that had been treated with agricultural chemicals.³³

In 186 migrant farmworker camps in North Carolina, surface wipe samples found widespread evidence of organophosphorus pesticides and pyrethroids in camps (94% and 97%, respectively).³⁴ Among 361 farmworkers living in these same camps, concentrations of urinary pesticide metabolites were higher than in the general American public.³⁰ This study discovered a direct correlation between measured concentrations of specific metabolites and living in camps with cockroach infestations and unclean kitchen conditions. Some metabolites were from household pesticides used to eradicate biting insects and cockroaches.³⁰ This study linked housing conditions, such as overcrowding and lack of screens, to pesticide metabolites. While inadequate sleeping-room size and dirty kitchens both were associated with a decreased detection of trichloropyridinol, pyrethroid metabolites were increased in camps with dirty kitchens.

Impact of Farmworker Housing on Health

There are relatively few systematic surveys of general health in the United States farmworker population; exceptions include Villarejo et al.³⁵ and Grzywacz et al.³⁶ These surveys and smaller clinic-based studies were not designed to comprehensively link farmworker health to housing conditions. We identified five exposure domains that, based on a review of housing and health literature and on our knowledge and experience, are most likely to have health effects. These exposures are the built environment; heat and contamination; structural defects and safety, mold, mildew, and other allergens; and pesticides. Where possible or relevant, we differentiate health effects on adults and children and on males and females. Within each section, we note where the research has been conducted and limitations of research designs employed.

Social Isolation and the Built Environment

Much of farmworker housing promotes social isolation of workers and their families from the wider society. Many workers live in rural areas and may be physically isolated in individual or group housing from other rural residents, particularly if the housing is farmworker-designated housing. Even in more urban settings, farmworkers—because of their work, poverty, discrimination, or language—may be isolated from other residents and have reduced access to resources. In both rural and urban communities, farmworkers may face homelessness because affordable housing is scarce.³⁷ Public health practitioners and

planners recognize that both physical structures and infrastructure affect the behaviors of a community's residents, which in turn affects their health.³⁸ Poor and marginalized residents may end up living near environmental and other hazards, an environmental injustice.³⁹

Typical rural farmworker housing in areas in the Midwest and southern United States creates conditions that directly facilitate exploitation of farmworkers (e.g., reduced access to police protection or other authority). Employers may have an incentive to keep worker housing hidden and inaccessible if they hire undocumented workers, but such isolation also creates conditions in which workers are vulnerable to abuse and may be denied their rights.⁴⁰ An ethnographic study in rural North Carolina found that the spatial and architectural composition of camps created living conditions potentially harmful to mental health; in particular, farmworkers were deprived of private space, creating a constancy of being with others.⁴¹ Farmworkers never had a place to call their own, as all available rooms were shared. With housing close to fields, lack of physical separation from the place of work created an inescapable association with work, even when in a place that is supposed to offer rest and respite from the work day.⁴¹ The ability of growers to enter the camp at any time created a sense of regulation and economic interest in maximizing productivity. Camps also are vulnerable to crime. They provide places for commercial sex workers hidden from the larger community; 18% to 28% of farmworkers in the eastern United States report contact with sex workers.^{42,43}

The isolation and geographic separation of camps historically have barred access to public means of communication. Thus, researchers have argued for installing public telephones in camps, both to communicate with family members and to reach help in emergencies.^{40,44,45} As personal cell phones have become more common, farmworkers have become less isolated, although cellular access varies among rural communities.

The housing conditions described for farmworkers affect mental health in nonfarmworker populations. Observed associations include exposure to acute noise, crowding, and malodorous pollutants associated with feelings of helplessness, reduced access to private space leading to feelings of lack of control, and crowding leading to social withdrawal and increased interpersonal conflict.⁷ In farmworker populations, most mental health studies have not directly focused on built environment or housing. However, studies in North Carolina found that social isolation was associated with both anxiety and depressive symptoms,⁴⁵ and crowding (as indicated by lack of personal space for belongings) was associated with depressive symptoms.⁴⁶ O'Connor et al.⁴⁷ found an association between housing disrepair (water leaks, mold in bathrooms) and *nervios*, a culturally defined condition of psychological stress. Kraemer-Diaz et al.⁴⁸ found interpersonal aggressive acts increased later in the season, when housing is crowded, and particularly when alcohol was consumed. None of these studies

included children, for whom the mental health consequences of housing conditions such as crowding may differ compared to adults.

Crowded housing conditions and poor ventilation can also increase transmission of infectious disease. For example, tuberculosis is spread through airborne droplets when an infected person coughs or talks. Rates of positive tuberculin skin tests in farmworkers have historically been about six times that of the general working population,⁴⁹ and incomplete treatment is common in farmworkers because they are transitory and have poor access to healthcare.⁵⁰ Transmission of community-associated methicillin-resistant *Staphylococcus aureus* (MRSA) infection is also increased by the crowded conditions common among farmworkers.⁴⁹ The isolated nature of their housing and increased potential for sex worker contact both increase farmworkers' risk for STD and HIV infection. However, despite the plausible linkages between housing and health and infectious disease, there are few data to substantiate or refute these connections.

Structural Defects in Housing and Injury Risk

Injury risk among farmworkers has been the subject of increasing interest, with emerging evidence of increased overall injury mortality and morbidity among this group.⁵¹ The classic epidemiologic paradigm of *agent*, *host*, and *environment* is useful for understanding patterns of observed or expected injuries related to farmworker housing. The *agent* for injury is energy.⁵² Thus, injury may be defined as tissue damage caused by exposure to energy outside of tissue tolerance. For example, in the case of falls, potential energy is transformed into kinetic energy in a falling worker; this energy is transferred suddenly to body tissues upon striking the ground. A fall from a low height may involve an energy transfer within tolerance of human tissue, and therefore injury is slight. A fall from greater heights may involve energy transfers beyond the tolerance of human tissue; bruising, bony fractures, or death may result.

The *host* population of agricultural workers comprises many persons who are new to agricultural work and unfamiliar with provided housing, and thus may not be able to avoid hazards.⁵¹ Linguistic and cultural barriers may exacerbate risk in this population, and such barriers are typically complicated by poverty and lack of access to health care.

The farmworker housing *environment* may hold many injury hazards, as workers spend a substantial portion of their nonwork hours in their dwellings and are therefore also exposed to risks associated with their housing environment (Table 2). Housing conditions among agricultural workers—especially migrant workers—are often substandard and include both traditional housing (houses, mobile homes, and barracks) and nontraditional dwellings (sheds, cars, and living out in the open). Despite housing surveys showing substandard

Table 2. Injury Hazards Related to Housing.

Hazard type	Examples
Design features	<ul style="list-style-type: none"> ● unprotected upper-story windows with low sills ● poorly designed stairs with inadequate lighting
Structural defects	<ul style="list-style-type: none"> ● weak or broken flooring ● uncovered shafts ● broken windows ● poor condition of sidewalks and walkways
Improper safety practices	<ul style="list-style-type: none"> ● chemicals stored with food and/or unlabeled ● absence of child-proof locks and electrical outlet coverings ● excessive water heater temperature
Electrical hazards	<ul style="list-style-type: none"> ● exposed wiring ● inadequate fuse or circuit-breaker protection ● use of portable appliances causing excessive current draw ● absence of ground-fault circuit interruption
Fire hazards	<ul style="list-style-type: none"> ● chimney defects ● absence of extinguishers ● absence of smoke and carbon monoxide detectors ● various electrical hazards

dwelling^s,^{24,26,53,54} relatively little attention has focused on injury among agricultural workers related to housing conditions.

Most studies of farmworker housing have reported on the prevalence of injury risks. Arcury et al.²⁶ surveyed housing at 183 employer-provided migrant farm worker camps in North Carolina using state migrant housing standards and reported a mean of 11.4 violations per camp. For example, 20% lacked proper fire extinguishers and 26% had improper or damaged flooring.²⁸ Camps inspected by the North Carolina Department of Labor, especially early in the season, and having H-2A visa workers were at lower risk for violations, possibly because such housing is more likely to be inspected and owners held to the proper standard.²⁶ Governmental inspection of housing quality may become increasingly difficult in locations such as California, as farmworkers find market housing in communities in the face of disappearing on-farm housing.⁵⁴

Agricultural work, especially harvesting operations, often occurs during the hottest part of the year. Rest in cool conditions, in particular for sleeping, may affect workers' ability to withstand hot conditions and remain alert to avoid injury. Quandt et al.³¹ assessed the heat index—a measure of temperature and humidity—in common and sleeping rooms in 170 North Carolina farmworker camps across a summer. Although air conditioning decreased average heat index

measurements, dangerously elevated index levels existed in most rooms regardless of whether air conditioning was used. Air conditioners were almost always small window units and likely insufficient. In these same dwellings, access to air conditioning was associated with improved sleep quality, lower prevalence of depression or anxiety, and lower levels of pain among 371 resident workers sampled from these camps.²⁵ Other investigators have documented an association between poor sleep quality and injury risk in Kentucky farmers.⁵⁵ Studies of sleep in hot and humid conditions indicate that when such conditions are present during the initial sleep stage, they disturb sleep quality by producing wakefulness and disturbing the body's temperature regulation.^{56,57} Pruritus, skin rashes, and scaling of the skin were significantly more likely in farmworkers who slept in rooms either not air conditioned or considered to be in the "thermal discomfort" range,⁵⁸ suggesting that other physical discomforts may also contribute to poor sleep quality in such conditions.

Heating systems are also needed in some farmworker housing during parts of the year. While no research exists on the health effects of defective heating systems, newspapers have reported deaths of farmworkers in Wisconsin and Florida who used charcoal grills inside housing for heat.

In summary, farmworkers, especially migrants seeking temporary housing, are at increased risk for living in substandard housing. Such housing is characterized by features that increase the risk for injury, both at the residence (e.g., fires and electrical hazards) and at work (e.g., lack of air conditioning that causes poor-quality sleep with an attendant increased risk of injury during work). However, data documenting housing-related injuries are needed.

Sanitation in Farmworker Housing and Illness

Foodborne and waterborne diseases can be major sources of morbidity in residents of housing with inadequate sanitation and opportunities for personal hygiene. Therefore, laundry, kitchen, and toilet facilities, as well as water quality, are typically foci of housing regulations. Evidence from farmworker housing suggests that these areas are problematic. For example, the CAWHS study found self-reported persistent diarrhea was significantly more common among workers in housing without complete bathroom or kitchen facilities.¹⁷ Crowding, particularly at times of high labor demands, may strain the limits of facilities to accommodate workers. The risk of illness is compounded by workers bringing higher levels of contamination into the housing than might be expected of nonfarmworker tenants. Many farmworkers experience inadequate field sanitation conditions,⁵⁹ and some come to the United States with a history of intestinal parasites.⁶⁰⁻⁶² General issues with sanitation in housing, such as cockroach and rodent infestation, difficulties in keeping older crowded housing clean, and inadequate trash removal, also increase the likelihood that

housing will be unsanitary. Overall, greater compliance with sanitation regulations is found in housing for workers with H-2A visas²⁹ and in housing with some evidence of inspection by a government agency.²⁶

The Occupational Safety and Health Administration (OSHA) has a standard for Temporary Labor Camps (29CFR 1910.142) that covers certain issues, including structural integrity and sanitation. For laundry facilities, OSHA regulations stipulate at least one laundry tray or tub per thirty persons. Of 44 camps studied in North Carolina, 20% failed this requirement; and the number of camps out of compliance increased through the summer as the camps became more crowded.²⁹ There are few other data available on laundry facilities in local housing rented by farmworkers.

OSHA regulations specify kitchen food storage space and conditions, which are particularly important for perishable foods needing refrigeration and for nonrefrigerated foods vulnerable to pests. In a study of 182 farmworker camps in eastern North Carolina, over 65% of camps had at least one refrigerator with an unsafe temperature (above 45°F)²⁸; at that temperature, some bacteria can double in 20 minutes.⁶³ Hot summer temperatures in housing, repeated opening of refrigerators during meal times, and older, malfunctioning units all contribute to risk of inadequate refrigeration. Farmworkers' attempts to keep food away from pests, such as hanging platforms from kitchen ceilings, have been observed in housing.⁶⁴ In a study in North Carolina, Quandt et al.²⁸ found cockroach infestation in 45.9% of kitchens and rodent infestation in 28.9%.

OSHA regulations related to bathrooms specify one showerhead per ten workers and one toilet per fifteen workers. Additional regulations specify spacing to provide privacy, with a minimum of two units for any shared facility. Outdoor privies can meet the toilet regulations. In one study of twenty-five farmworker camps in eastern North Carolina, 7% had latrines and 7% had portable bathrooms.⁶⁰ Lack of dividers between toilets and showers can effectively reduce the number of units available, as workers wait to use facilities alone. Arcury et al.²⁴ found such privacy concerns in over 42% of camps evaluated in North Carolina. Whalley et al.²⁹ found that most farmworkers showered more than an hour after arriving home from work; such a delay may be due, in part, to poor access to shower facilities.

Water quality is an ongoing problem in farmworker housing. In 1974, a large outbreak of typhoid was reported among workers at a migrant labor camp in Dade County, Florida, likely due to a contaminated water supply.⁶⁵ Studies collecting data from the late 1980s through 2010 in eastern North Carolina found that high proportions of water samples from farmworker camps failed total coliform tests (44%, 50%, and 34% in 1988, 1989, and 2010, respectively).^{62,27} Both studies found increasing prevalence of problems during the summer agricultural season. The early studies found an association between the presence of latrines and poor water quality.⁶²

Mold, Mildew, and Other Allergens

An extensive literature has linked housing characteristics related to water—including dampness, mold, and mildew—to adverse health effects, particularly respiratory and allergic symptoms such as cough, wheezing, upper respiratory symptoms, and symptoms of asthma.^{66,67} It is estimated that the attributable risk for respiratory infections and bronchitis from these housing conditions is 8% to 20%.⁶⁸ New-onset asthma has also been linked to measures of dampness,⁶⁹ with atopy increasing the risk.⁷⁰ Allergens from cockroaches and other pests also have been implicated in associations between housing characteristics and respiratory outcomes.⁶ Farmworkers who live in homes with significant mold and moisture problems as well as pest infestation are at higher risk of developing these adverse respiratory and allergic health effects. Of particular concern is the development of new-onset asthma, especially in children.

Indicators of dampness and pest infestation in farmworker housing have been reported as part of the generally low housing quality. In North Carolina, Arcury et al.²⁴ reported water damage in 53% of sleeping rooms, evidence of dwelling leaks during rain in 20%, and shower mold in 35% of dwellings. Evidence of infestation for cockroaches (73%) and mice (55%) was high. In California, Bradman et al.⁴ found high wall moisture in 26% of housing and moderate to extensive mold in 43%. Cockroach and rodent infestation (60% and 32%, respectively) also was high.

Few studies have examined associations in farmworker populations of such housing problems and health outcomes. Bradman et al.⁴ found cockroach antigen in dust significantly correlated with evidence of cockroach infestation, but no difference in cockroach infestation or antigen between homes among children with or without asthma. This finding is at odds with studies in nonfarmworker inner-city children that correlated childhood asthma with cockroach antigen.⁷¹ Water damage and mold were associated with increased risk of pest infestation, but this study did not examine the association between health outcomes and moisture or mold problems. Gustafson et al.⁵⁸ found that dampness and humidity in farmworker housing were associated with increased prevalence of skin rash, which could indicate allergy.

While one might assume that farmworkers should have the same health effects as the general population in terms of mold, moisture, and environmental triggers of allergy and asthma, there are few data with which to assess this notion. Farmworkers may not be able to control outdoor exposure to conditions that may be triggers, such as pesticide spraying, thus complicating attempts to study associations between housing and conditions known to induce respiratory effects in other populations.⁷²

Pesticides and Other Toxins and Farmworker Housing

Farmworkers can be exposed in their housing to agricultural pesticides, both through drift from applications to nearby fields and through the “take home” pathway, as pesticides enter housing on work clothing, footwear, and on workers’ skin.⁷³ Exposure to residential pesticides also is possible when such chemicals are used to control pests in the home or yard.

A substantial literature documents the exposure of farmworkers and their family members to pesticides within housing. It is largely concentrated on California, Oregon, and Washington State on the West Coast and North Carolina in the eastern United States.

In California, pesticide evidence is largely confined to two study locations: the Salinas Valley of Monterey County and Mendota, located in Fresno County. In the Salinas Valley studies, multiple matrices, including carpet and floor dust, indoor air, floor and toy surfaces, and child clothing worn indoors for testing, showed organophosphorus pesticides (e.g., chlorpyrifos and diazinon), pyrethroids (e.g., *cis*-Permethrin and *trans*-Permethrin), and herbicides (chlorthal-dimethyl) in nearly all samples, and the organochlorine pesticides DDE and DDT in many samples.³² Dialkylphosphate breakdown products of organophosphorus pesticides in house dust also were common.⁷⁴ Household inventories in the same community found stored pesticides for residential applications that included pyrethroids, carbamates, and organophosphorus pesticides.⁴ In Mendota, pyrethroids were measured in house dust,⁷⁵ showing high frequencies of *cis*-Permethrin, *trans*-Permethrin, and other pyrethroids. Levels of such pesticides in dust are correlated with household pesticide inventories.

In Oregon, home dust samples in farmworker housing located close to agricultural production areas frequently contained detectable levels of azinphos methyl and less frequently had detectable levels of other organophosphorus pesticides.^{76,77} In Washington State, multiple studies of farmworker households have shown that concentrations of organophosphorus pesticides commonly used in orchard crop production (azinphosmethyl, chlorpyrifos, parathion, and phosmet) are present in the house dust of workers’ families in higher concentrations than in house dust from homes of reference families.^{33,78,79} Concentrations of pesticides in household dust have been associated with pesticide metabolites in urine samples from child and adult residents.^{33,79,80}

In North Carolina, a study of camps occupied by migrant farmworkers found organophosphorus and pyrethroid pesticides in 166 and 171 of 176 dwellings, respectively.³⁴ A number of different pesticides were associated with housing violations and with housing characteristics such as crowding. Family housing assessed with floor wipes found that at least one agricultural pesticide was detected in 44% of 41 homes and at least one residential pesticide in 95% of homes.⁸¹ The presence of at least one agricultural pesticide was associated with housing adjacent to fields; greater numbers of residential pesticides were

associated with houses judged as more difficult to clean. Urine samples were collected from adults and children in eight of these forty-one households and analyzed for organophosphorus pesticide metabolites.⁸² Higher levels of metabolites in households were related to living in rental housing, not owning a vacuum cleaner, and housing judged difficult to clean.

Despite this evidence that both agricultural and residential pesticides are present in homes of farmworkers, and evidence that individuals are absorbing these pesticides, research to demonstrate health effects from pesticides in housing is scant. It is likely that such a link will remain difficult to establish, for several reasons. Pesticides are ubiquitous in the environment. Because they are used extensively in agriculture employing farmworkers, these workers are exposed at work as well as in their homes. Separating effects of home or work exposure will be extremely difficult. In addition, effects of pesticides on health (except for poisonings due to large doses, which are rare) take years to develop and are difficult to detect even in very large study samples, because of the multiple factors that affect the development of the health conditions thought to be linked to pesticides (e.g., degenerative diseases, cancer, and reproductive effects).

Farmworker housing, both grower-provided and rental, may expose residents to lead from peeling, cracked, or chipped paint, as has been observed in several studies,^{14,22,25} if the paint was produced prior to 1978. Children in such housing are particularly at risk. However, no data are available to document such exposure.

Summary and Recommendations

The proportion of farmworkers who are settled is increasing, particularly in areas such as California where the growing season is long and agricultural production is year round. In other areas such as the Midwest, Northeast, Northwest, and Southeast, where there is a greater seasonality to production, farm labor continues to include both migrant and settled seasonal workers. Regardless of whether migrant or seasonal, housing options for farmworkers are severely limited.

Farmworkers are a socially vulnerable population in a number of ways: They are low-income ethnic minorities and often are recent immigrants who lack authorization for employment in the United States. They also have low educational attainment and limited English fluency. Few workers are eligible for needs-based government programs and many lack social support. Even within farmworkers, hierarchies of vulnerability exist.^{83,84} Indigenous-language speakers, largely from southern Mexico and Central America, are at particular risk of “falling through the cracks,” whereas farmworkers with citizenship and Spanish or English language skills have substantially more opportunities.^{84,85}

The housing available to farmworkers varies by region. Grower-supplied housing is still common in regions where migrant workers are employed.

However, an increasing proportion of farmworkers lives in market-rate housing within towns and even large cities.

Housing occupied by farmworkers includes both rural and urban residences, much of it crowded and in poor repair. The literature demonstrates that this housing increases the chances of exposures with negative health consequences. These exposures include physical isolation, proximity to toxic waste disposal sites, contaminated drinking water, poor air quality, structural defects, electrical hazards, pest infestation, failure to meet minimal sanitation standards, presence of mold and mildew, and pesticide contamination. Some workers live in circumstances not intended for human habitation, such as farm outbuildings, unfinished garages, abandoned vehicles, crude shacks, and in the open.

Although the housing and health literature establishes the exposures described earlier for nonfarmworker populations, very little research has examined how farmworker housing conditions affect the health status of the occupants. Filling this research void should proceed from knowledge of where workers live and the condition of their housing. While there is reasonably comprehensive knowledge of housing conditions for North Carolina and California, information of comparable quality is sorely lacking for other regions. Criteria for producing comparative data are found elsewhere.⁸⁶

Research Recommendations

Based on the review of the literature presented, the need for research on the impact of farmworker housing conditions on health is clear.

Recommendation 1. New research is needed that simultaneously assesses housing conditions and the health status of resident farmworkers and their family members. This effort should include, at a minimum:

Recommendation 1a: Housing conditions assessment should include in-home measures used by local housing code or migrant housing inspectors, as well as collection of environmental samples for relevant exposures (e.g., allergens and pesticides).

Recommendation 1b: Health assessment should include all farmworkers, but focus on the most vulnerable individuals, such as children, older adults, and those with preexisting conditions of asthma or other respiratory diseases. Health status measures should address both physical and mental health outcomes likely associated with housing conditions. Research should include evaluation of any healthy home interventions in the farmworker population.

Recommendation 1c: Sampling should focus on variability within the farmworker population—including unaccompanied foreign-born workers, migrant families, and settled families—as well as variability in housing types (e.g., barracks, farmhouses, and trailers). Regional variability needs to be

addressed so sufficient housing units and workers are sampled in different areas of the country, to be able to characterize and contrast these areas.

Recommendation 2. A nationally valid cross-sectional survey of the condition of housing currently utilized by farmworkers is needed. One possible approach would be to extend the NAWS survey to include housing inspection for a subset of NAWS participants. Another would be to nest a study of farmworker housing within the American Healthy Homes Survey, conducted by the United States Department of Housing and Urban Development.

Policy Recommendations

Recommendation 1. Strengthen enforcement of health-related standards for farmworker housing. Revise housing standards and housing code based on research recommended above. Available evidence suggests that existing housing regulations are inconsistently enforced for migrant housing. Whether this is because of understaffing for inspections by regulatory agencies or weak penalties invoked for housing that does not pass inspection, better enforcement is essential for improving housing conditions. We recommend that the ratio of inspectors to camps be substantially increased. Additional evidence, particularly from repeated inspections,^{24,26,34} suggests that migrant housing in passable condition at preoccupancy inspection deteriorates during the season as workers are in residence. Thus, we recommend requiring inspections during occupancy. Similarly, we recommend requiring water testing during the season to detect contamination that may result from inadequate septic systems.

Proactive inspection and greater enforcement of existing housing codes is also needed for housing in the local housing market occupied by farmworkers. The current practice of inspections only in reaction to complaints is not adequate for farmworker housing, because they are unlikely to know the procedures or be willing to complain to local authorities. Better enforcement of code elements related to crowding, and repair can reduce health risks for respiratory and infectious disease, as well as injury. Enforcement must promote repairs, not evictions of vulnerable workers.

Housing codes should be expanded to cover known hazards. In particular, such codes should mandate healthier pest control strategies to restrict application of pesticides within residences and institute integrated pest management practices.

Recommendation 2. The public health and medical workforces serving the farmworker population need to be strengthened. Health agencies should report health problems that may be attributed to housing to the appropriate regulatory agencies. Housing inspectors should inquire as to the health of the occupants and make appropriate referrals. Training to understand the connections between housing and health is needed at all levels of these workforces.

Recommendation 3. Create positive incentives for enhancing the supply of good-quality housing for farmworkers. This will require ongoing conversations among various stakeholders: local and state housing and planning officials, employers, farmworkers, builders, and others. Incentives could include, for example, direct subsidies or tax benefits for builders and other groups involved in supplying affordable housing.

OSHA Disclaimer

One of the authors of this paper, Kathleen Fagan, is a medical officer with the OSHA at the United States Department of Labor. Any opinions or recommendations expressed in this paper do not necessarily reflect official views or policy of OSHA or United States Department of Labor. This paper is not a standard or regulation, and it neither creates new obligations nor alters existing obligations created by OSHA standards or the Occupational Safety and Health Act.

Acknowledgments

This report was produced for the conference “Farmworker Housing Quality and Health: A Transdisciplinary Conference,” organized by the Center for Worker Health, Wake Forest School of Medicine, California Rural Legal Assistance, Inc., and Farmworker Justice.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Financial support for the conference was provided by the National Institute of Environmental Health Sciences (grant R13 ES023709); the United States Department of Agriculture; California Rural Legal Assistance; Inc.; Southeast Center for Agricultural Health & Injury Prevention, University of Kentucky (grant U54 OH007547); Southwest Center for Agricultural Health, Injury Prevention, and Education (grant U54 OH07541); and Western Center for Agricultural Health and Safety, University of California, Davis (grant U54OH009550). Funding via Grant Numbers ES 023709, OH 007547, OH 07541, OH 009550. ESO23709 supported the conference for which the paper was developed. The other grants supported the conference. OH 009550 supported Stephen A. McCurdy. All are US Government grants.

References

1. Peck S. Many harvests of shame: housing for farmworkers. In: Belden JN and Wiener RJ (eds) *Housing in rural America*. Thousand Oaks, CA: Sage, 1998, pp.83–90.

2. Hood E. Dwelling disparities: how poor housing leads to poor health. *Environ Health Perspect* 2005; 113: A310–A317.
3. Shaw M. Housing and public health. *Annu Rev Public Health* 2004; 25: 397–418.
4. Bradman A, Chevri er J, Tager I, et al. Association of housing disrepair indicators with cockroach and rodent infestation in a cohort of pregnant Latina women and their children. *Environ Health Perspect* 2005; 113: 1795–1801.
5. Bouchard MF, Chevri er J, Harley KG, et al. Prenatal exposure to organophosphate pesticides and IQ in 7-year old children. *Environ Health Perspect* 2011; 119: 1189–1195.
6. Northridge J, Ramirez OF, Stingone JA, et al. The role of housing type and housing quality in urban children with asthma. *J Urban Health* 2010; 87: 211–224.
7. Evans GW. The built environment and mental health. *J Urban Health* 2003; 80(4): 536–554.
8. Arcury TA and Quandt SA. Delivery of health services to migrant and seasonal farmworkers. *Annu Rev Public Health* 2007; 28: 345–363.
9. Villarejo D. The health of U.S. hired farm workers. *Annu Rev Public Health* 2003; 24: 175–193.
10. Kandel W. Economic research service, United States department of agriculture. Hired farmworkers: a major input for some U.S. farm sectors. *Amber Waves*, April 2008.
11. United States Department of Labor. Office of the Assistant Secretary for Policy. Office of Programmatic Policy. *Findings from the national agricultural workers survey (NAWS) 2001–2002. A demographic and employment profile of United States farm workers*. Research report no. 9, March 2005. Washington, DC: Author.
12. Carroll D. National agricultural workers survey: overview of the survey and public data file. Seminar presentation, department of economics, university of California Davis, Davis, CA, www.doleta.gov/agworker/naws.cfm (accessed 15 July 2014).
13. Carroll D, Saltz R and Gabbard S. The changing farm workforce. Findings from the national agricultural workers survey. In: *Paper presented at the immigration reform: implications for farmers, farm workers, and communities conference*, Washington, DC, 21–22 May 2009.
14. Holden C, Lance G and Smith A. *No refuge from the fields: findings from a survey of farmworker housing conditions in the United States*. Washington, DC: Housing Assistance Council, 2001.
15. Early J, Davis SW, Quandt SA, et al. Housing characteristics of farmworker families in North Carolina. *J Immigr Minor Health* 2006; 8(2): 173–184.
16. Gentry AL, Grzywacz JG, Quandt SA, et al. Housing quality among North Carolina farmworker families. *J Agric Saf Health* 2007; 13(3): 323–337.
17. Villarejo D. The challenge of housing California’s hired farm laborers. In: Marcouiller D and Lapping M (eds) *Rural housing, exurbanization, and amenity-driven development*. Farnham, England: Ashgate Publishing Limited, 2011, pp.193–206.
18. Bay area economics. *2012 Napa county farmworker housing needs assessment*. Draft report. 20 February 2013, p.91.
19. Villarejo D and McCurdy SA. The California agricultural workers health survey. *J Agric Saf Health* 2008; 14(2): 135–146.

20. Myers D, Baer WC and Choi S. The changing problem of overcrowded housing. *J Am Plann Assoc* 1996; 62(1): 66–84.
21. Eggers FJ and Gouad M. American housing survey: analysis of trends in household composition using American housing survey data. Prepared for US department of housing & urban development, December, 2013, http://www.huduser.org/publications/pdf/AHS_HouseholdComposition_v2.pdf (2015, accessed 7 June 2015).
22. Washington State Farmworker Housing Trust. *A sustainable bounty: investing in our agricultural future*. Seattle, WA: Washington State Farmworker Survey, 2008.
23. Vallejos QM, Quandt SA, Grzywacz JG, et al. Migrant farmworkers' housing conditions across an agricultural season in North Carolina. *Am J Ind Med* 2011; 54: 533–544.
24. Arcury TA, Weir MM, Summers P, et al. Safety, security, hygiene and privacy in migrant farmworker housing. *New Solutions* 2012; 22(2): 153–173.
25. Sandberg JC, Talton JW, Quandt SA, et al. Association between housing quality and individual health characteristics on sleep quality among Latino farmworkers. *J Immigr Minor Health* 2014; 16(2): 265–272.
26. Arcury TA, Weir M, Chen H, et al. Migrant farmworker housing regulation violations in North Carolina. *Am J Ind Med* 2012; 55(3): 191–204.
27. Bischoff WE, Weir M, Summers P, et al. The quality of drinking water in North Carolina farmworker camps. *Am J Public Health* 2012; (102): e49–e54.
28. Quandt SA, Summers P, Bischoff WE, et al. Cooking and eating facilities in migrant farmworker housing in North Carolina. *Am J Public Health* 2013; 103(3): e78–e84.
29. Whalley LE, Grzywacz JG, Quandt SA, et al. Migrant farmworker field and camp safety and sanitation in eastern North Carolina. *J Agromedicine* 2009; 14(4): 421–436.
30. Raymer JH, Studabaker WB, Gardner M, et al. Pesticide exposures to migrant farmworkers in eastern NC: detection of metabolites in farmworker urine associated with housing violations and camp characteristics. *Am J Ind Med* 2014; 57(3): 323–337.
31. Quandt SA, Wiggins MF, Chen H, et al. Heat index in migrant farmworker housing: implications for rest and recovery from work-related heat stress. *Am J Public Health* 2013; 103(8): e24–e26.
32. Bradman A, Whitaker D, Quirós L, et al. Pesticides and their metabolites in the homes and urine of farmworker children living in the Salinas valley, CA. *J Expo Sci Environ Epidemiol* 2007; 17(4): 331–349.
33. Lu C, Fenske RA, Simcox NJ, et al. Pesticide exposure of children in an agricultural community: evidence of household proximity to farmland and take home exposure pathways. *Environ Res* 2000; 84(3): 290–302.
34. Arcury TA, Lu C, Chen H, et al. Pesticides present in migrant farmworker housing in North Carolina. *Am J Ind Med* 2014; 57(3): 312–322.
35. Villarejo D, McCurdy SA, Bade B, et al. The health of California's immigrant hired farmworkers. *Am J Ind Med* 2010; 53(4): 387–397.
36. Grzywacz JG, Alterman T, Gabbard S, et al. Job control, psychological demand, and farmworker health: evidence from the National agricultural workers survey. *J Occup Environ Med* 2014; 56(1): 66–71.
37. Ag Innovations Network. *Shelter + Mobility. Recommendations for California's specialty crop Ag workforce*. Sebastopol, CA: Ag Innovations Network, 2014.

38. Aboelata MT. *The built environment and health: 11 profiles of neighborhood transformation*. Oakland, CA: The Prevention Institute. http://www.preventioninstitute.org/index.php?option=com_jlibrary&view=article&id=114&Itemid=127 (2004, accessed 10 January 2012).
39. Foy KC. Home is where the health is: the convergence of environmental justice, affordable housing, and green building. *Pace Environmental Law Review* 2012; 30(1): 1–57.
40. Bail KM, Foster J, Dalmida SG, et al. The impact of invisibility on the health of migrant farmworkers in the southeastern United States: a case study from Georgia. *Nurs Res Pract* 2012; 760418: 1–8.
41. Benson P. El Campo: faciality and structural violence in farm labor camps. *Cult Anthropol* 2008; 23(4): 589–629.
42. Parrado EA, Flippen CA and McQuiston C. Use of commercial sex worker among Hispanic migrants in North Carolina: implications for the spread of HIV. *Perspect Sex Reprod Health* 2004; 36: 150–156.
43. Viadro CI and Earp JA. The sexual behavior of married Mexican immigrant men in North Carolina. *Soc Sci Med* 2000; 50(5): 723–735.
44. Grzywacz JG, Quandt SA, Early J, et al. Leaving family for work: ambivalence and mental health among Mexican migrant farmworker men. *J Immigr Minor Health* 2006; 8(1): 85–97.
45. Hiott AE, Grzywacz JG, Davis SW, et al. Migrant farmworker stress: mental health implications. *J Rural Health* 2008; 24(1): 32–39.
46. Grzywacz JG, Quandt SA, Chen H, et al. Depressive symptoms among Latino farmworkers across the agricultural season: structural and situational influences. *Cultur Divers Ethnic Minor Psychol* 2010; 16(3): 335–343.
47. O'Connor K, Stoecklin-Marois MT and Schenker MB. Examining *nervios* among immigrant male farmworkers in the MICASA Study: socioeconomic, housing conditions and psychosocial factors. *J Immigr Minor Health* 2015; 17(1): 198–207.
48. Kraemer-Diaz AE, Weir MM, Isom S, et al. Interpersonal conflict among male migrant farmworkers living in camps in eastern North Carolina. *J Immigr Minor Health* 2015. Epub ahead of print.
49. Rhodes SD. Tuberculosis, sexually transmitted diseases, HIV, and other infections among farmworkers in the Eastern United States. In: Arcury TA and Quandt SA (eds) *Latino farmworkers in the eastern United States*. New York, NY: Springer, 2009, pp.131–152.
50. Centers for Disease Control. Prevention and control of tuberculosis in migrant farm workers: recommendations of the advisory council for the elimination of tuberculosis. *MMWR* 1992; 41(RR–10): 1–15.
51. McCurdy SA and Carroll DJ. Agricultural injury. *Am J Ind Med* 2000; 38(4): 463–480.
52. Robertson LS. *Injury epidemiology*. New York, NY: Oxford University Press, 1992.
53. Villarejo D, Lighthall D, Williams D, et al. *Suffering in silence: a report on the health of California's agricultural workers*. Los Angeles, CA: California Institute for Rural Studies & The California Endowment, 2000.
54. Villarejo D. California's hired farm workers move to the cities: the outsourcing of responsibility for farm labor housing. In: *California rural legal assistance priorities conference*, Asilomar, California, 24 January 2014.

55. Spengler SE, Browning SR and Reed DB. Sleep deprivation and injuries in part-time Kentucky farmers: impact of self-reported sleep habits and sleep problems on injury risk. *AAOHN J* 2004; 52(9): 373–382.
56. Okamoto-Mizuno K, Tsuzuki K and Mizuno K. Effects of humid heat exposure in later sleep segments on sleep stages and body temperature in humans. *Int J Biometeorol* 2005; 49(4): 232–237.
57. Okamoto-Mizuno K and Mizuno K. Effects of thermal environment on sleep and circadian rhythm. *J Physiol Anthropol* 2012; 31: 14.
58. Gustafson CJ, Feldman SR, Quandt SA, et al. The association of skin conditions with housing conditions among North Carolina Latino migrant farmworkers. *Int J Dermatol* 2014; 53(9): 1091–1097.
59. Arcury TA, Quandt SA, Cravey AJ, et al. Farmworker reports of pesticide safety and sanitation in the work environment. *Am J Ind Med* 2001; 39(5): 487–498.
60. Russell MD, Correa MT, Stauber CE, et al. North Carolina Hispanic farmworkers and intestinal parasitism: a pilot study of prevalence and health-related practices, and potential means of foodborne transmission. *J Food Prot* 2010; 73(5): 985–988.
61. Hotez PJ. Neglected infections of poverty in the United States of America. *PLoS Negl Trop Dis* 2008; 2(6): e256.
62. Ciesielski S, Seed JR, Estrada J, et al. The seroprevalence of cysticercosis, malaria, and *Trypanosoma cruzi* among North Carolina migrant farmworkers. *Public Health Rep* 1993; 108(6): 736–741.
63. Centers for disease control and prevention. Food safety, <http://www.cdc.gov/food-safety> (2011, accessed 10 January 2012).
64. Quandt SA and Arcury TA. Farmworker housing: implications for food security and food safety. *Rural Voices* 2013; 18(3): 12–14.
65. Feldman RE, Baine WB, Nitzkin JL, et al. Epidemiology of salmonella Typhi infection in a migrant labor camp in Dade county, Florida. *J Infect Dis* 1974; 130(4): 334–342.
66. Institute of Medicine. *Damp indoor spaces and health*. Washington, DC: National Academies Press, 2004.
67. Mendell MJ, Mirer AG, Cheung K, et al. Respiratory and allergic health effects of dampness, mold, and dampness-related agents: a review of the epidemiologic evidence. *Environ Health Perspect* 2011; 119(6): 748–756.
68. Fisk WJ, Elisevva EA and Mendell MJ. Association of residential dampness and mold with respiratory tract infections and bronchitis: a meta-analysis. *Environ Health* 2010; 9: 72.
69. Quansah R, Jaakkola MS, Hugg TT, et al. Residential dampness and molds and the risk of developing asthma: a systematic review and meta-analysis. *PLoS One* 2012; 7(11): e47526.
70. Norbäck D, Zock JP, Plana E, et al. Mould and dampness in dwelling places, and onset of asthma: the population-based cohort ECRHS. *Occup Environ Med* 2013; 70(5): 325–331.
71. Rosenstreich DL, Eggleston P, Kattan M, et al. The role of cockroach allergy and exposure to cockroach allergen in causing morbidity among inner-city children with asthma. *N Engl J Med* 1997; 336(19): 1356–1363.

72. Postma JM, Smalley K, Ybarra V, et al. The feasibility and acceptability of a home-visitation, asthma education program in a rural, Latino/a population. *J Asthma* 2011; 48(2): 139–146.
73. Quandt SA, Hernández-Valero M, Grzywacz JG, et al. Workplace, household, and personal predictors of pesticide exposure for farmworkers. *Environ Health Perspect* 2006; 114(6): 943–952.
74. Quirós-Alcalá L, Bradman A, Smith K, et al. Organophosphorous pesticide breakdown products in house dust and children's urine. *J Expo Sci Environ Epidemiol* 2012; 22(6): 559–568.
75. Trunnelle KJ, Bennett DH, Tancredi DJ, et al. Pyrethroids in house dust from the homes of farm worker families in the MICASA Study. *Environ Int* 2013; 61: 57–63.
76. McCauley LA, Lasarev MR, Higgins G, et al. Work characteristics and pesticide exposures among migrant agricultural families: a community-based research approach. *Environ Health Perspect* 2001; 109(5): 533–538.
77. McCauley LA, Michaels S, Rothlein J, et al. Pesticide exposure and self-reported home hygiene: practices in agricultural families. *AAOHN J* 2003; 51(3): 113–119.
78. Simcox NJ, Fenske RA, Wolz SA, et al. Pesticides in household dust and soil: exposure pathways for children of agricultural families. *Environ Health Perspect* 1995; 103(12): 1126–1134.
79. Coronado GD, Vigoren EM, Thompson B, et al. Organophosphate pesticide exposure and work in pome fruit: evidence for the take-home pesticide pathway. *Environ Health Perspect* 2006; 114(7): 999–1006.
80. Curl CL, Fenske RA, Kissel JC, et al. Evaluation of take-home organophosphorus pesticide exposure among agricultural workers and their children. *Environ Health Perspect* 2002; 110(12): A787–792.
81. Quandt SA, Arcury TA, Rao P, et al. Agricultural and residential pesticides in wipe samples from farmworker family residences in North Carolina and Virginia. *Environ Health Perspect* 2004; 112(3): 382–387.
82. Arcury TA, Quandt SA, Rao P, et al. Organophosphate pesticide exposure in farmworker family members in western North Carolina and Virginia: case comparisons. *Hum Organ* 2005; 64: 40–51.
83. Holmes S. *Fresh fruit, broken bodies: migrant farmworkers in the United States*. Berkeley: University of California Press, 2013.
84. Holmes SM. Structural vulnerability and hierarchies of ethnicity and citizenship on the farm. *Med Anthropol* 2011; 30(4): 425–449.
85. Farquhar SA, Goff NM, Shadbeh N, et al. Occupational health and safety status of indigenous and Latino farmworkers in Oregon. *J Agric Saf Health* 2009; 15(1): 89–102.
86. Arcury TA, Gabbard S, Bell B, et al. Collecting comparative data on farmworker housing and health: a tool for collecting housing and health data across places and time. *New Solutions* 2015; 25: 287–312.

Author Biographies

Sara A. Quandt is a professor in the Department of Epidemiology and Prevention, Wake Forest School of Medicine, Winston-Salem, North

Carolina, where she is also an associate director of the Center for Worker Health.

Carol Brooke is a staff attorney with the Workers' Rights Project of the North Carolina Justice Center.

Kathleen Fagan is a medical officer in the Office of Occupational Medicine and Nursing, Occupational Safety and Health Administration, Washington, DC.

Allyson Howe is a community outreach worker at Farmworker Legal Services of Michigan.

Thomas K. Thornburg is a managing attorney for Farmworker Legal Services of Michigan. He serves on the State of Michigan Interagency Migrant Services Council.

Stephen A. McCurdy is a vice chair and professor in the Department of Public Health Sciences, School of Medicine, University of California, Davis.