Public Health Impact of Heat-Related Illness Among Migrant Farmworkers

Nancy L. Fleischer, PhD, Hope M. Tiesman, PhD, Jeri Sumitani, PA-C, Terry Mize, PA-C, Kumar Kartik Amarnath, A. Rana Bayakly, MPH, Matthew W. Murphy, PhD

Background: Migrant farmworkers are at risk for heat-related illness (HRI) at work.

Purpose: The purpose of this study was to determine which risk factors could potentially reduce the prevalence of HRI symptoms among migrant farmworkers in Georgia.

Methods: Trained interviewers conducted in-person interviews of adults who attended the South Georgia Farmworker Health Project clinics in June 2011. The analysis was conducted in 2011–2012. Population intervention models were used to assess where the greatest potential impact could be made to reduce the prevalence of HRI symptoms.

Results: In total, 405 farmworkers participated. One third of participants had experienced three or more HRI symptoms in the preceding week. Migrant farmworkers faced barriers to preventing HRI at work, including lack of prevention training (77%) and no access to regular breaks (34%); shade (27%); or medical attention (26%). The models showed that the prevalence of three or more HRI symptoms (n=361, 34.3%) potentially could be reduced by increasing breaks in the shade (−9.2%); increasing access to medical attention (−7.3%); reducing soda intake (−6.7%); or increasing access to regular breaks (−6.0%).

Conclusions: Migrant farmworkers experienced high levels of HRI symptoms and faced substantial barriers to preventing these symptoms. Although data are cross-sectional, results suggest that heat-related illness may be reduced through appropriate training of workers on HRI prevention, as well as regular breaks in shaded areas.

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Introduction

Migrant farmworkers face substantial occupational hazards, but their health-related issues frequently go unaddressed because of inadequate health care and safety training.[1–4] Continued exposure to heat, in particular, can cause symptoms ranging from mild signs to death.[1,5–8] Heat-related illness (HRI) can occur as a result of prolonged exposure to high temperature. Heat exhaustion is a common type of HRI and includes such symptoms as heavy sweating, weakness, dizziness, fatigue, fainting, nausea or vomiting, and headaches. If untreated, symptoms may progress to heat stroke,[9] which is a severe illness characterized by, but not limited to, elevation of core body temperature, delirium, convulsions, or coma; it can result in death.[10]

Between 2003 and 2009 in the U.S., there were 232 worker fatalities attributable to exposure to environmental heat, according to the Census of Fatal Occupational Injuries, which includes seasonal and migrant workers. Of these deaths, 90% occurred during summer months (n=208), more than half in southern states (n=133), and nearly one quarter on farms or agriculture sites (n=49).[11]

Georgia has experienced a sharp rise in summer temperatures in recent years; the two hottest summers ever recorded were in 2010 and 2011,[12] and there is concern about heat exposure among migrant farmworkers in this area. To gain a better understanding of the context for potential interventions, the goals of the current paper were to (1) determine the knowledge and practices concerning HRI and barriers to its prevention among

From the Epidemic Intelligence Service assigned to the National Center for Environmental Health (Fleischer), National Center for Environmental Health (Murphy), CDC; Physician Assistant Program (Sumitani, Mize), Emory University; Chronic Disease, Healthy Behaviors and Injury Epidemiology Section (Bayakly), Georgia Department of Public Health, Atlanta, Georgia; National Center for Occupational Safety and Health (Tiesman), CDC, Morgantown, West Virginia; and Department of Biology (Amarnath), DePauw University, Greencastle, Indiana

Address correspondence to: Nancy L. Fleischer, PhD, University of South Carolina Arnold School of Public Health, 800 Sumter Street, Columbia SC 29208. E-mail: nfleischer@sc.edu.

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migrant farmworkers and (2) assess where the greatest potential impact could be made to reduce HRI in this population.

Methods

A cross-sectional survey of migrant farmworkers who attended the Emory University Physician Assistant Program's South Georgia Farmworker Health Project (www.emorypa.org/farmworker) was conducted during June 11–23, 2011, in Decatur and Echols counties in south Georgia. Farmworkers included any person working in the agricultural industry, including, but not limited to, crop workers, nursery workers, and crew leaders. Trained interviewers conducted in-person interviews of adults aged ≥18 years in Spanish, English, or Haitian Creole; all participants spoke one of these languages sufficiently to complete the interview, even if it was not their primary language. All data were self-reported. The study protocol was approved through the CDC IRB human research review process, the U.S. government Office of Management and Budget, and the Georgia Department of Public Health IRB. All interviewees gave informed consent.

The survey was developed based on previous agricultural surveys.[6,13] Study participants answered questions about their demographic characteristics; health status and behaviors; housing and working conditions; HRI symptoms; and knowledge and practices regarding HRI. Demographic characteristics included age, gender, education, ethnicity, and primary spoken language. Health status questions included BMI (from measured height and weight) and chronic disease status. Health behaviors included drinking alcohol (number of drinks in an average week) and smoking status (current, former, and never-smokers).

Respondents answered questions about who provided their housing, whether they had air conditioning or a fan at home, and whether they go somewhere to cool down during the day when not at work. Participants responded to questions about farm work, including the number of years they had worked in agriculture in the U.S., how long they had been working in agriculture in Georgia or nearby states that year, and their main job tasks. They also answered questions regarding access to shade, regular breaks, lunch breaks, medical attention, toilets, water at work, and training to prevent HRI.

Symptoms of HRI (sudden muscle cramps; nausea or vomiting; hot, dry skin; confusion; dizziness; fainting; headache) were assessed for the preceding week; responses were summed to determine the total number of symptoms experienced. Participants answered whether they drank more water, alcohol, sports drinks, energy drinks, coffee or caffeinated teas, soda, and juice during hot and humid weather. Respondents also answered whether they *always/usually/sometimes/rarely/never* practiced specific prevention activities while working and spending time outside in hot and humid weather: *take breaks in the shade*; *wear loose, lightweight clothing*; *wear long-sleeved shirts*; *wear long pants*; *wear a wide-brimmed hat*; *wear sunscreen*; *avoid over-exerting yourself*; *go to air conditioned places during rest breaks or after work*; *drink more water than usual*; *change your work duties*; *change the hours that you work or spend time outside*.

The analysis was conducted in 2011–2012. Population intervention models[14,15] were used to assess areas with the greatest potential impact on reduction of HRI symptoms. These models compare a counterfactual world (in which all subjects are given some ideal baseline exposure level) to the current conditions in the population. The models effectively standardize the estimates so that one can compare across risk factors. The population intervention parameter is $E(Y_a) - E(Y)$, or the difference between the expected value of experiencing HRI symptoms for those at the optimal level of exposure (a) and the actual prevalence of symptoms in the population. This estimate is based on both the strength of the association and the prevalence of the risk factor in the population.

For the population intervention analysis, the population of interest was nonpregnant farmworkers only, because many pregnancy symptoms overlap with HRI symptoms. The outcome of interest was experiencing three or more symptoms in the past week. Because HRI symptoms are common and general symptoms, using three or more symptoms was designed to improve the identification of HRI specifically.

Risk factors related to prevention behaviors and barriers to prevention were chosen by first running bivariate logistic regression models. All risk factors with a p-value <0.20 were considered for further analysis. Next, optimal baseline levels, if one were able to intervene in the population, for each risk factor were selected that would be the ideal level of the exposure, based on recommendations for hydration and heat protection in work settings.[8,16–18]

Finally, models were run using the multi-population intervention model package in the statistical software R for each risk factor separately, while adjusting for the potential confounders of age, gender, Hispanic ethnicity, education, BMI, chronic disease status, alcohol use, smoking status, type of work, hours worked/day, and days worked/week (except when examining these factors, or when the risk factor preceded the potential confounder). Potential confounders were chosen if they are risk factors for HRI and also are potentially associated with the variables in the model analysis. The targeted maximum likelihood option was used to estimate the point estimates and inference. Analyses were conducted with Stata 11.2 and R 2.13.2.

Results

A total of 1179 adults attended the Emory University Physician Assistant Program's South Georgia Farmworker Health Project. Of these, 468 farmworkers and community members participated, for a participation rate of 39.7%. This paper focuses on the 405 farmworkers, and excludes the 63 community members. The mean age of the participants was 36 years, and more than 80% of the participants were men (Table 1). On average, participants had attended just more than 6 years of school. Most respondents (80%) were ethnically Hispanic, and Spanish was the most common primary language (63%). However, 17% of the participants spoke a non-Spanish indigenous language, and 15% spoke Haitian Creole.

The mean BMI was 27 kg/m^2; a total of 60% of respondents were overweight or obese. One tenth reported being diagnosed with a chronic disease. Most participants did not drink any alcoholic beverages in a week (65%), and 15% were current smokers. Respondents reported

Table 1. Sociodemographic and farm work characteristics of study sample, Georgia, 2011

Characteristic	N=405[a]
Age (years), M±SD (range)	35.8±13.2 (18–93)
Male gender	326 (80.5)
Education (years), M±SD (range)	6.6±3.8 (0–16)
Hispanic	321 (79.5)
Primary spoken language	
Spanish	254 (63.0)
Indigenous language	69 (17.1)
Haitian Creole	61 (15.1)
English	17 (4.2)
French	2 (0.5)
BMI, M±SD (range)[b]	26.6±4.8 (15.7–44.8)
Body weight category (BMI)[b]	
Underweight (<18.5)	9 (2.3)
Normal weight (18.5–<25)	151 (38.0)
Overweight (25–<30)	155 (39.0)
Obese (≥30)	82 (20.7)
Ever diagnosed with a chronic disease	41 (10.3)
Average alcoholic beverages drink each week, M±SD (range)	2.7±8.0 (0–102)
Drink no alcohol	258 (64.5)
Smoking status	
Current smoker	61 (15.4)
Former smoker	52 (13.2)
Never-smoker	282 (71.4)
Number of years, including this year, in agriculture in U.S., M±SD (range)	7.2±8.5 (1–49)
First year in agriculture in U.S.	87 (21.4)
Time spent working in agriculture this year, weeks	
<1	1 (0.3)
1–4	52 (13.0)
>4	347 (86.8)
Days worked per week, M±SD (range)	5.6±1.0 (2–7)
Hours worked per day, M±SD (range)	9.2±2.0 (3–15)
Tasks performed[c]	
Planting	11 (2.7)
Cultivating	32 (7.9)
Harvesting or picking crops	281 (69.4)
Loading, packing, or transporting outdoors	92 (22.7)
Loading, packing, or transporting indoors	30 (7.4)
Most common crops worked[c]	
Corn	153 (37.8)
Peppers (sweet and chilis)	110 (27.2)
Tomatoes	90 (22.2)
Eggplants	55 (13.6)
Pumpkins	24 (5.9)
Cucumbers	22 (5.4)

Note: n (%) unless otherwise indicated
[a]When responses do not add up to N=405, this is due to missing data.
[b]Nonpregnant farmworkers only
[c]Could select more than one

working in agriculture in the U.S. for 7 years on average, although it was the first year for 21% of them. Participants reported working nearly 6 days a week and 9 hours a day on average, and mostly picked crops or loaded, packed, or transported crops outdoors. The most common crops were corn, peppers, and tomatoes.

In terms of HRI symptoms in the preceding week, more than half the respondents reported experiencing a headache while working or spending time outside (Table 2). Having hot, dry skin; sudden muscle cramps; or dizziness was reported by 25%–45% of those interviewed. More than 15% experienced nausea or vomiting, or confusion, and 4% had fainted in the preceding week while working or spending time outside. Most participants (71%) reported experiencing at least one symptom, and one third reported experiencing three or more symptoms in the past week. Only 24% of the participants reported receiving some type of HRI prevention training during the year.

Farmworkers also were asked about HRI prevention practices. When asked if they drank *more* of various beverages during hot and humid weather, most reported drinking more water (95%) and more sports drinks (84%). However, many also were drinking more juice (63%); soda (54%); and energy drinks (22%). Most "rarely" or "never" wore sunscreen (74%) or wide-brimmed hats (67%). More than half said they "rarely" or "never" changed work duties (64%) or changed the hours they worked or spent time outside during hot and humid weather (63%).

Table 2. Heat-related illness symptoms, and knowledge and practices related to heat-related illness prevention, Georgia, 2011

Characteristic	N=405[a]
Heat-related illness symptoms experienced in past week	
Headache	204 (50.8)
Hot, dry skin	180 (44.9)
Sudden muscle cramps	135 (33.7)
Dizziness	98 (24.6)
Nausea or vomiting	67 (16.7)
Confusion	61 (15.5)
Fainting	17 (4.4)
Number of heat-related illness symptoms	
0	118 (29.4)
1	79 (19.7)
2	69 (17.2)
3	61 (15.2)
4	34 (8.5)
5	25 (6.2)
6	11 (2.7)
7	5 (1.2)
Symptoms experienced in past week, M±SD (range)	1.9±1.8 (0–7)
Training this year on heat-illness prevention	95 (23.5)
Go somewhere to cool down during day when not working	177 (43.8)
Days in past week spent free time exercising outside, M±SD (range)	1.1±1.8 (0–7)
Ever removed personal protective equipment due to heat	170 (43.6)
Drink more of beverage during hot and humid weather	
Water	383 (95.3)
Sports drinks	337 (83.8)
Juice	251 (62.6)
Soda	215 (53.5)
Energy drinks	87 (21.6)
Coffee or tea	27 (6.8)
Alcohol	26 (6.5)
Rarely or never participate in prevention practice	
Wear sunscreen	294 (73.7)
Wear wide-brimmed hat	271 (67.4)
Wear long-sleeved shirt	78 (19.5)
Wear long pants	8 (2.0)
Drink more water	15 (3.8)
Wear loose, lightweight clothing	16 (4.0)
Avoid overexertion	100 (26.1)
Change work duties	255 (63.8)
Change hours of work or spend time outside	252 (62.7)
Go to air-conditioned places during breaks or after work	153 (38.2)
Take breaks in shady areas	81 (20.2)
Potential barriers to heat illness prevention at work	
No access to regular breaks	137 (33.9)
No access to shade	110 (27.2)
No access to medical attention	106 (26.2)
No access to lunch breaks	27 (6.7)
No access to a toilet	17 (4.2)
No access to employer-provided clean drinking water	13 (3.2)
Potential barriers to heat illness prevention at home	
Housing provided by grower or crew chief	276 (68.3)
No air-conditioning	103 (25.5)
No fan	125 (31.1)

Note: n (%) unless otherwise indicated

[a]When responses do not add up to N=405, this is due to missing data.

Farmworkers also faced several potential barriers to heat illness prevention. Nearly 70% of participants lived in housing provided by their grower or crew chief, which may represent a lack of control over the location or condition of the housing. One quarter of participants' homes had no air conditioning. At work, farmworkers often had no access to regular breaks (34%); shade (27%); or medical attention (26%).

To determine where the greatest potential impact could be made to reduce HRI in this population, several variables were assessed with population intervention models. For this analysis, the 361 nonpregnant participants for whom there were data for all variables of interest were used. Experiencing three or more HRI symptoms in the preceding week was the outcome of interest (prevalence=34.3% for 361 respondents). In bivariate logistic regression models, 17 of the 43

Table 3. ORs for heat-related illness (≥3 symptoms) and prevention practices with ideal baselines (n=361), Georgia, 2011

Prevention practice	OR (95% CI)[a]	Ideal baseline
Education level (years)	0.96 (0.91, 1.01)	>6 years
Drink more water (always/usually vs other)	1.68 (0.84, 3.34)	Always/usually
Drink more sports drinks (yes vs no)	1.87 (1.01, 3.47)	Yes
Drink more soda (yes vs no)	1.83 (1.20, 2.79)	No
Drink more juice (yes vs no)	1.46 (0.95, 2.27)	No
Alcohol (drinks/week)	1.02 (0.99, 1.05)	0 drinks/week
Wear sunscreen (always/usually vs other)	0.67 (0.37, 1.21)	Always/usually
Go somewhere to cool down (yes vs no)	1.46 (0.96, 2.22)	Yes
No. of work days/ week	1.21 (0.97, 1.52)	<6
No. of work hours/ day	1.09 (0.98, 1.22)	<9
Time in Georgia this year (>4 weeks vs ≤4 weeks)	1.69 (0.87, 3.28)	>4 weeks
Load/pack outside (yes vs no)	1.41 (0.87, 2.29)	No
Access to medical attention (yes vs no)	0.46 (0.30, 0.70)	Yes
Access to regular breaks (yes vs no)	0.53 (0.34, 0.81)	Yes
Access to shade (yes vs no)	0.73 (0.46, 1.15)	Yes
Change work duties (always/usually vs other)	0.60 (0.32, 1.12)	Always/usually
Take breaks in shady areas (always/usually vs other)	0.53 (0.34, 0.82)	Always/usually

[a]Estimates are based on n=361 participants who were not pregnant and had complete data on all covariates of interest.

examined risk factors had a $p<0.20$, meeting the criteria for further examination (Table 3). Exposures included social determinants of health, hydration techniques, personal prevention behaviors, and work-related prevention strategies and barriers to prevention.

The strongest associations of HRI symptoms were with working conditions and hydration techniques. If the estimates are shown to be causal and valid, intervening on these conditions and techniques may yield the greatest reductions in HRI symptoms (Figure 1). If all participants could always or usually take breaks in the shade, the prevalence of three or more symptoms could be reduced by 9.2% (95% CI= −15.2%, −3.1%), from 34.3% to 25.2%. Other risk factors associated with HRI included having access to medical attention at work and having access to regular breaks (population intervention parameter: −7.3% and −6.0%, respectively). Drinking more water or more sports drinks were each associated with a potential increase in HRI symptoms. Thus, if farmworkers did *not* drink more soda in hot and humid weather, this could potentially reduce HRI symptoms by 6.7%, from 34.3% to 27.6%.

Discussion

Migrant farmworkers in south Georgia experienced high levels of HRI symptoms and faced a number of barriers to preventing heat illness at work and at home. Most study participants did not have training on how to prevent HRI. Farmworkers worked long days, with limited control over their work schedule and job tasks. The strongest associations of HRI symptoms were with working conditions and hydration techniques, particularly taking breaks in the shade, having access to medical attention, taking regular breaks, and limiting soda intake.

Heat-related illness can be challenging to define and to recognize clinically. A wide spectrum of processes, from benign heat rash to multiple organ failure, contributes to the complexity of accurate diagnosis. Additionally, individuals respond differentially to heat stress. Here, previously identified symptoms and markers of HRI in farmworkers were used.[6]

During data collection for the current study, temperatures ranged between 95°F and 104°F, and the heat index was 100°F or hotter every day, peaking at 108°F (www.wunderground.com). In the sample, 71% of participants had experienced at least one symptom in the preceding week while working or spending time outside when including headache as a symptom, and 63% of participants had experienced at least one symptom when excluding headache. Both of these percentages far exceed the 40% who reported at least one symptom (excluding headache) "while working in extreme heat" in a 2009 study from North Carolina.[6] This discrepancy may be due to environmental conditions, the shortened recall period in this study, or variation in prevention behaviors between the populations. It also is possible that because data collection was conducted in conjunction with the

South Georgia Farmworker Health Project clinics, the farmworkers attending the clinics experienced more symptoms. However, many attended the clinics for general wellness checks, because they do not have routine access to care. Additionally, more-severe symptoms also were reported, such as nausea or vomiting (17%) and confusion (16%).

When asked about methods to prevent heat illness, 20% responded that they rarely or never take breaks in shady areas, and 38% responded that they rarely or never go to air-conditioned places during breaks to cool down. In addition, 64% of workers reported rarely or never changing work duties, and 63% rarely or never changed work hours or limited their time spent outside. Many respondents commented on the inability to negotiate work conditions, including work hours and duties.

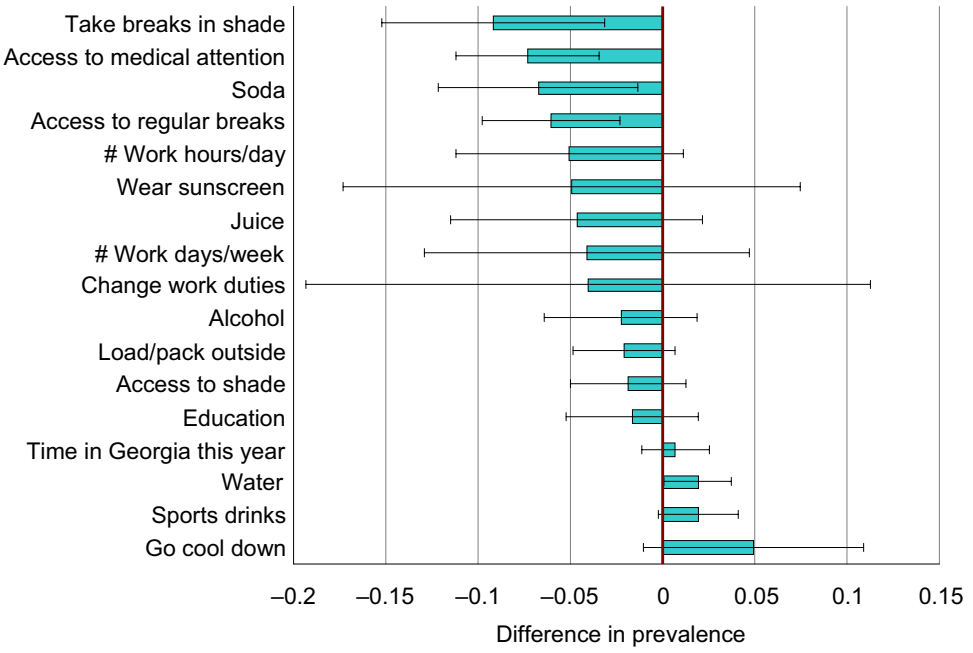

Figure 1. Difference in prevalence of three or more heat-related illness symptoms (n=361, prevalence=34.3%), Georgia, 2011

It is possible that farmworkers have difficulty executing prevention practices because of the way they are financially compensated. Farmworkers are often paid by production at a predetermined piece rate, which promotes fast-paced work schedules with few interruptions. An hourly wage structure may help alleviate workers' internal pressure for production. However, farmworkers face other obstacles to preventing HRI, including social isolation, which has been found to increase risk of death during heat waves.[19–21] Changing the pay structure might serve as one step toward preventing HRI.

In the population intervention model analysis, several risk factors were associated with reductions in HRI symptoms and had important potential for intervention: allowing farmworkers to take breaks in the shade, increasing access to medical attention, providing access to regular breaks, and reducing soda consumption. Historically, the most effective interventions for reducing injuries in the workplace include those that focus on administrative policies or engineering modifications, rather than on employee-based behavioral change.[22] Administrative or engineering changes, such as modified work assignments, water misting systems, or mobile shade units, also may have potential to reduce heat-related illness.

No federal occupational standard specifically addresses HRI prevention, although some state-based standards have been adopted.[8] In 2005, the California Occupational Safety and Health Administration (OSHA) implemented the nation's first emergency heat stress regulation, requiring employers to provide shade, water, access to regular breaks, and training on HRI prevention to their employees.[16] This standard was the basis for a permanent regulation aimed at the agriculture, construction, landscaping, and oil/gas extraction industries.[16] In 2007, Washington issued a similar regulation.[17] In 2011, federal OSHA announced a national initiative to educate workers about the hazards of working outdoors and the prevention of HRI.[23]

Although having regular access to medical care is not part of the current regulations, the population intervention model analyses indicate that access to care may be helpful for HRI prevention. Healthcare providers may promote prevention activities, including how to prevent HRI.[24] Other possibilities, which require further research, are that medical care access indicates a generally more health-conscious work environment or that workers are familiar with early signs and symptoms that merit attention.

Promoting worker understanding of hydration techniques, particularly reducing soda consumption, may

serve as a helpful strategy. Although limited, existing research indicates that soda is inferior to water and sports drinks for hydration,[25] and public health experts recommend avoiding drinks with sugar and caffeine (because of its diuretic properties).[9,18] An unexpected finding from the current study was that drinking more water and sports drinks during hot and humid weather showed a potential increase in symptoms. Because the data were cross-sectional, this may be a case of reverse causation (i.e., people who were experiencing more symptoms may have consumed more water or sports drinks to alleviate symptoms). Another possibility is that the workers typically drink more water or sports drinks, but did not do so during the week of the questionnaire (HRI symptoms were reported for the preceding week, but prevention strategies were reported for periods of hot and humid weather in general).

Limitations

Because of the cross-sectional nature of the data and the phrasing of some questions (e.g., asking in general about hydration techniques rather than in the preceding week), the current results represent associations only, and reverse causation is also a possibility. Additionally, all data were self-reported, except height and weight measurements. However, recall periods were short in order to reduce recall bias.

Because only farmworkers who attended the mobile clinics in south Georgia were interviewed, the findings have limited generalizability to the greater U.S. migrant farmworker population. It also is possible that there is selection bias, particularly if those with less education or less access to health care were less likely to attend and if those with more HRI symptoms were more likely to attend. Additionally, the participation rate was just below 40%; no sample of those who did not participate was evaluated to determine if their HRI symptoms differed. However, the participation rate may be an underestimate because the authors had no way of knowing how many people attended the clinic but were not told about the study.

An additional limitation is that HRI symptoms are common and general symptoms that are not specific to HRI. However, participants were asked if they experienced the symptoms "while working or spending time outside" in an attempt to specify the event. HRI symptoms also overlap with symptoms caused by green tobacco illness. However, only 3% of farmworkers in the current study were working with tobacco. Farmworkers were not asked if they were taking any medication that may have put them at risk for HRI.

Conclusion

Migrant farmworkers in south Georgia experienced high levels of HRI symptoms. Interventions on work environments and hydration techniques may help reduce this burden. Because changing the work environment is not typically within the control of workers themselves, employers could assist by providing regular breaks in shaded areas, and employer-sponsored training on HRI prevention may be a useful intervention approach.

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