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Symptoms of Heat Illness Among Latino Farmworkers in North Carolina

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Abstract

Background—Symptoms of occupational heat illness provide an early warning that workers are in potentially life-threatening environmental conditions.

Purpose—This analysis was designed to assess the extent to which strategies to reduce the health impact of extreme heat were associated with the prevalence of heat illness among Latino farmworkers.

Methods—Between June and September 2009, 300 Latino men and women participated in a cross-sectional survey about farmworker health. Participants reported whether they were employed through the H-2A temporary agricultural worker program and whether they had ever worked in conditions of extreme heat during their work in the U.S. agricultural industry. Workers who had worked in extreme heat also responded to questions about selected activities and behaviors and whether they experienced symptoms of heat illness. Data analysis was conducted in 2009 to assess associations of altering work hours and activities, drinking more water, resting in shaded areas, and going to air-conditioned places during or after work, with the prevalence of symptoms of heat illness among H-2A and non-H-2A workers.

Results—Working in extreme heat was reported by 281 respondents (94%), among whom 112 (40%) reported symptoms of heat illness. Changes in work hours and activities during hot conditions were associated with a lower prevalence of heat illness among H-2A workers, but not among non-H-2A workers.

Conclusions—These findings suggest the need to improve the understanding of working conditions for farmworkers and to assess strategies to reduce agricultural workers' environmental heat exposure.

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Introduction

Muscle cramps, heat syncope, heat exhaustion, heat stroke, and other heat-related conditions have been reported among people working outdoors (e.g., in agriculture¹ and construction²), in hot indoor or enclosed environments (e.g., drivers² and miners^{3;4}), and who wear heavy equipment and whose jobs require considerable physical exertion (e.g., athletes,⁵ firefighters,² and military personnel^{6;7}). As of 2009, California and Washington each have occupational safety standards for agriculture that address outdoor heat exposure.^{8;9} A review of medical examiner records in North Carolina identified a large number of heat-related fatalities among farmworkers,¹⁰ suggesting that strategies to prevent occupational heat illness among farmworkers could have an important impact on heat stroke fatality overall.

Non-immigrant foreign workers brought to the U.S. to work in temporary and seasonal agricultural labor jobs are contracted through the H-2A (type of visa) temporary agricultural worker program.¹¹ Better working conditions and more safety behaviors have been reported among H-2A workers than among other workers,¹² although differences in occupational activities and workplace safety practices have not been thoroughly investigated. Using data collected during the 2009 agricultural season, this analysis was conducted to describe the characteristics of H-2A and non-H-2A farmworkers who reported working in conditions of extreme heat. This paper presents self-reported data about strategies to prevent heat illness and associations between these strategies and heat illness among farmworkers.

Methods

Between June and September 2009, 300 Latino farmworkers participated in a cross-sectional study designed to assess several dimensions of farmworker health. Participants were recruited from the sites maintained as living quarters for migrant farmworkers (i.e., farmworker camps) in three contiguous counties in North Carolina. Spanish-speaking study personnel approached 62 camps during the recruitment stage of the study; workers in eight declined to participate and the owners, who are also the farmworkers' employers, of two refused to allow study personnel to recruit in the camps. After 157 refusals, 300 farmworkers (66%) were successfully recruited from 52 camps. The Wake Forest University School of Medicine IRB approved the study protocol and instruments, and each participant provided written informed consent.

Participants completed interviewer-administered questionnaires in Spanish and reported working in conditions of extreme heat by responding to the following question: "During your work in agriculture in the U.S. (including this year), have you worked in conditions of extreme heat?" Participants with positive responses were asked follow-up questions to assess adaptive strategies and heat-related symptoms. The five adaptive strategies included changing work hours, changing work activities, drinking more water, resting in shaded areas, and going to air-conditioned places during or after work. To assess heat-related symptoms, participants reported whether they ever experienced any of the following symptoms while working in extreme heat: confusion; dizziness; fainting; hot, dry skin; muscle cramps; and nausea or vomiting. Individuals who reported any of the symptoms were identified as having experienced heat illness. Participants also reported their ages, educational attainment, housing type, H-2A status, gender, whether they spoke English, and years of experience working in the U.S. agricultural industry. Workers who reported having an H-2A visa were categorized as H-2A workers; all others were categorized as non-H-2A workers.

Data analysis was conducted in 2009 to assess characteristics of the study population by H-2A status, by experience working in extreme heat, and of the workers who reported heat illness. Associations between the strategies to reduce the health impact of heat and heat-related illness were estimated using log-binomial regression. Associations are presented as prevalence ratios

(PR) with 95% CIs, adjusted for educational attainment (0–6, 7–9, 10–16 years), housing type (barracks, house, trailer), and years of experience working in the U.S. agricultural industry (<1, 1–6, 7+ years). All analyses were performed using SAS version 9.1 (SAS Institute Inc., Cary, NC).

Results

Table 1 shows characteristics of the 300 participants. The remaining analyses were restricted to 281 participants (94%) who reported working in extreme heat, among whom 112 (40%) reported heat-related symptoms. Heat illness was less common among H-2A workers (31% vs 56%) and the percentage of participants with specific symptoms ranged from 1% (fainting) to 22% (sudden muscle cramps) among H-2A workers and 6% to 44% among non-H-2A workers, respectively.

The majority of participants reported drinking more water (98%) and taking rest breaks in shaded areas (81%) (Table 2). Smaller percentages reported changes in their work hours (37%) or work activities (34%), and only 6 (2%) reported going to an air-conditioned place to rest during or after work. Each adaptive strategy was more common among non-H-2A workers. Among H-2A workers, heat illness was inversely associated with each of the adaptive strategies and particularly with reported changes in work hours and activities (PR: 0.44; 95% CI: 0.22, 0.89). This inverse association was not observed in the population of non-H-2A workers (PR: 1.11; 95% CI: 0.79, 1.55). Adjusting the final models for the timing of the interview throughout the summer generated PRs closer to unity for all models, including, most notably, those for H-2A workers who reported changes in their work activities (PR: 0.55; 95% CI: 0.28, 1.09) and all workers who reported changes in work hours and activities (H-2A: PR: 0.48; 95% CI: 0.23, 0.99; non-H-2A: PR: 0.95; 95% CI: 0.62, 1.45).

Discussion

Nearly 94% of the surveyed population reported working in extreme heat. Despite not having information about in which other geographic regions the participants may have worked in the past, this high percentage is unsurprising given that the participants were farmworkers interviewed in a region where hot and humid conditions are common throughout the summertime. Of these respondents, nearly all reported drinking more water or taking breaks in shaded areas while working. North Carolina does not currently have regulations addressing heat exposure in the agricultural industry, and the two primary prevention measures included in the current survey (namely, changing work hours and changing work activities) were uncommon. This is a concern, given the potential for heat-related illnesses to turn fatal. These findings suggest that while working in extreme heat, the use of strategies to reduce exposure or prevent heat illness varies by H-2A worker status. In this survey, the adaptive strategies were reported less frequently among H-2A workers, as were the symptoms of heat illness.

This study has limitations that should be considered when interpreting the findings and developing future research. The survey did not include information about the frequency, severity, timing, or geographic location of the exposure or the heat-related symptoms. These data and information about workplace safety practices and access to medical attention would yield useful information with which to assess causal associations among working conditions, prevention strategies, and heat illness. Information about specific work-related changes and validation of this information would provide insight into the extent to which workers and their supervisors view hot weather as a dangerous condition. Improvements in the ascertainment or verification of individual heat-related symptoms would improve the sensitivity and specificity of the definition of heat illness.

Men and women working in the agricultural industry work long hours, and those who work outdoors are likely to work in intensely hot and humid weather conditions that place them at risk of exertional and classic heat illness. The current data suggest a need for more information about the working conditions of populations working in environments or conditions that place them at risk of heat illness and improvements in our understanding of the functional consequences of these working conditions. These findings also indicate an urgent need for rigorous research of hypotheses about strategies to reduce workers' exposure to extreme heat, acclimatization to hot and humid conditions in agricultural work environments, and symptoms of heat-related illness.

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References

1. Heat-related deaths among crop workers—U.S. 1992–2006. *MMWR Morb Mortal Wkly Rep* 2008;57(24):649–653. [PubMed: 18566563]
2. Bonauto D, Anderson R, Rauser E, Burke B. Occupational heat illness in Washington State, 1995–2005. *Am J Ind Med* 2007;50(12):940–950. [PubMed: 17972253]
3. Donoghue AM, Sinclair MJ, Bates GP. Heat exhaustion in a deep underground metalliferous mine. *Occup Environ Med* 2000;57(3):165–174. [PubMed: 10810098]
4. Donoghue AM. Heat illness in the U.S. mining industry. *Am J Ind Med* 2004;45(4):351–356. [PubMed: 15029567]
5. Finch CF, Boufous S. The descriptive epidemiology of sports/leisure-related heat illness hospitalisations in New South Wales, Australia. *J Sci Med Sport* 2008;11(1):48–51. [PubMed: 17931973]
6. Hakre S, Gardner JW, Kark JA, Wenger CB. Predictors of hospitalization in male Marine Corps recruits with exertional heat illness. *Mil Med* 2004;169(3):169–175. [PubMed: 15080232]
7. Gardner JW, Kark JA, Karnei K, Sanborn JS, Gastaldo E, Burr P, et al. Risk factors predicting exertional heat illness in male Marine Corps recruits. *Med Sci Sports Exerc* 1996;28(8):939–944. [PubMed: 8871901]
8. Heat Illness Prevention, Title 8 California Code of Regulations, Sec. 3395.
9. Outdoor Heat Exposure, Washington State Safety Standards for Agriculture. Chapter 296-307-097.
10. Mirabelli MC, Richardson DB. Heat-related fatalities in North Carolina. *Am J Public Health* 2005;95(4):635–637. [PubMed: 15798122]
11. Immigration and Nationality Act, Title 8 U.S. Code Section 218. Admission of Temporary H-2A Workers.
12. Whalley LE, Grzywacz JG, Quandt SA, Vallejos QM, Walkup M, Chen H, et al. Migrant farmworker field and camp safety and sanitation in eastern North Carolina. *J Agromedicine* 2009;14(4):421–436. [PubMed: 19894164]

Table 1

Characteristics of the H-2A and non-H-2A farmworker study populations

	H-2A workers			Non-H-2A workers		
	n (%)	Worked in extreme heat n (%) ^b	Heat illness n (%) ^{a,b}	n (%)	Worked in extreme heat n (%) ^b	Heat illness n (%) ^{a,b}
Study population	194 (100)	177 (91)	54 (31)	106 (100)	104 (98)	58 (56)
Age, years						
18–27	36 (19)	32 (89)	10 (31)	38 (36)	37 (97)	16 (43)
28–33	59 (30)	54 (92)	14 (26)	14 (13)	13 (93)	8 (62)
34–41	53 (27)	47 (89)	16 (34)	22 (21)	22 (100)	12 (55)
42–65	46 (24)	44 (96)	14 (32)	32 (30)	32 (100)	22 (69)
Educational attainment, years						
0–6	88 (45)	80 (91)	20 (25)	73 (69)	72 (99)	46 (64)
7–9	88 (45)	82 (93)	27 (33)	27 (26)	26 (96)	11 (42)
10–16	18 (9)	15 (83)	7 (47)	6 (6)	6 (100)	1 (17)
English spoken						
No	178 (92)	163 (92)	51 (31)	87 (82)	85 (98)	49 (58)
Yes	16 (8)	14 (88)	3 (21)	19 (18)	19 (100)	9 (47)
Housing						
Barracks	72 (37)	66 (92)	24 (36)	30 (28)	29 (97)	14 (48)
House	63 (33)	56 (89)	11 (20)	30 (28)	29 (97)	14 (48)
Trailer	59 (30)	55 (93)	19 (35)	46 (43)	46 (100)	30 (65)
Gender						
Female	2 (1)	2 (100)	0 (0.0)	13 (12)	13 (100)	10 (77)
Male	192 (99)	175 (91)	54 (31)	93 (88)	91 (98)	48 (53)
Survey period						
June 24–July 4	63 (33)	56 (89)	17 (30)	15 (14)	14 (93)	7 (50)
July 5–July 18	43 (22)	34 (79)	12 (35)	33 (31)	32 (97)	16 (50)
July 19–August 5	42 (22)	42 (100)	16 (38)	30 (28)	30 (100)	23 (77)
August 5–September 6	46 (24)	45 (98)	9 (20)	28 (26)	28 (100)	12 (43)
Years in U.S. agriculture						
<1	15 (8)	12 (80)	4 (33)	25 (24)	23 (92)	11 (48)
1–6	74 (38)	69 (93)	18 (26)	51 (48)	51 (100)	26 (51)

	H-2A workers		Non-H-2A workers		
	<i>n</i> (%)	Worked in extreme heat <i>n</i> (%) ^{<i>a</i>} ^{<i>b</i>}	Heat Illness <i>n</i> (%) ^{<i>a</i>} ^{<i>b</i>}	Worked in extreme heat <i>n</i> (%) ^{<i>b</i>}	Heat illness <i>n</i> (%) ^{<i>a</i>} ^{<i>b</i>}
7+	105 (54)	96 (91)	32 (33)	30 (28)	21 (70)

^{*a*}Row percentages

^{*b*}Denominators are the numbers of participants who reported working in hot weather

Table 2
Associations of heat illness prevention strategies with heat illness among H-2A and non-H-2A farmworkers

Prevention Strategies	H-2A workers (n=177)			Non-H-2A workers (n=104)		
	n (%)	Heat Illness n (%) ^a	PR (95% CI) ^b	n (%)	Heat Illness n (%) ^a	PR (95% CI) ^b
Total Population		54 (31)			58 (56)	
Change work hours	61 (35)	12 (20)	0.58 (0.33, 1.03)	42 (40)	24 (57)	1.18 (0.84, 1.64)
Change work activities	53 (30)	9 (17)	0.50 (0.26, 0.96)	43 (41)	25 (58)	1.21 (0.87, 1.69)
Drink more water	172 (97)	53 (31)	0.86 (0.14, 5.29)	103 (99)	58 (56)	—
Rest breaks in shaded areas	130 (73)	37 (29)	0.68 (0.43, 1.10)	97 (93)	54 (56)	1.20 (0.64, 2.26)
Air-conditioned places during breaks or after work	1 (<1)	1 (100)	—	5 (5)	4 (80)	1.27 (0.61, 2.64)
Change hours or activities	62 (35)	13 (21)	0.63 (0.36, 1.10)	45 (43)	27 (60)	1.28 (0.91, 1.80)
Change hours and activities	52 (29)	8 (15)	0.44 (0.22, 0.89)	40 (39)	22 (55)	1.11 (0.79, 1.55)

^aRow percentages

^bAdjusted for educational attainment, housing type, years in U.S. agriculture

PR: prevalence ratio