Journal of Agromedicine
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/wagr20

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Published online: 03 Aug 2015.

To cite this article: June T. Spector, Jennifer Krenz & Kristina N. Blank (2015) Risk Factors for Heat-Related Illness in Washington Crop Workers, Journal of Agromedicine, 20:3, 349-359, DOI: 10.1080/1059924X.2015.1047107

To link to this article: http://dx.doi.org/10.1080/1059924X.2015.1047107

Journal of Agromedicine, 20:349–359, 2015

ISSN: 1059-924X print/1545-0813 online
DOI: 10.1080/1059924X.2015.1047107

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ABSTRACT. Crop workers are at high risk of heat-related illness (HRI) from internal heat generated by heavy physical work, particularly when laboring in hot and humid conditions. The aim of this study was to identify risk factors for HRI symptoms in Washington crop workers using an audio computer-assisted self-interview (A-CASI) instrument that has undergone reliability and validity evaluation. A cross-sectional A-CASI survey of 97 crop workers in Washington State was conducted during the summer of 2013. Potential HRI risk factors in demographic, training, work, hydration, clothing, health, and environmental domains were selected a priori for evaluation. Mixed-effects logistic regression was used to identify risk factors for self-reported symptoms associated with heat strain and HRI (dizziness/light-headedness or heavy sweating) experienced at work in hot conditions. An increase in age was associated with a lower odds of HRI symptoms (odds ratio [OR] = 0.92; 95% confidence interval [CI] = 0.87–0.98). Piece rate compared with hourly payment (OR = 6.20; 95% CI = 1.11–34.54) and needing to walk for more than 3 minutes to get to the toilet, compared with less than 3 minutes (OR = 4.86; 95% CI = 1.18–20.06), were associated with a higher odds of HRI symptoms. In this descriptive study of risk factors for HRI symptoms in Washington crop workers, decreased age (and less work experience), piece rate pay, and longer distance to the toilet were associated with self-reported HRI symptoms. Modifiable workplace factors should be considered in HRI prevention efforts that are evaluated using objective measures in representative working populations.

KEYWORDS. Agricultural workers, crop workers, farmworkers, heat-related illness, risk factors

INTRODUCTION

Internal heat generation from heavy physical work, particularly when performed in hot and humid environmental conditions, contributes to the development of exertional heat-related illness (HRI) in agricultural workers. Heat-related illnesses can range in severity from relatively mild (e.g., heat rash) to heat stroke and death. Unlike classical heat stroke, exertional HRI can affect young, otherwise healthy workers.[1] Crop workers, who often perform physically demanding tasks in workplace environments without adequate cooling or hydration, are disproportionately affected.[1−3] Between 2003 and 2008, the United States (US) agriculture, forestry, and fishing sector had the highest mean heat fatality rate (approximately 0.3 deaths/100,000 full-time workers) compared with all US industries (0.02 deaths/100,000 full-time workers).[1,2] In

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Washington (WA) State, the average annual HRI workers' compensation claims incidence rate per 100,000 full-time equivalent workers in the agriculture and forestry sectors between July and September from 1995 and 2009 was 15.7.[3] The actual rate of HRI is probably substantially higher than estimated using workers' compensation data because HRI is likely underrecognized and underreported.[3] The risk of HRI is expected to increase over time as the frequency and severity of heat events increases.[4–6]

The principles of human heat balance, physiology, and the results of research studies, primarily in athletes and the military, form the basis for recommendations and regulations intended to prevent HRI in outdoor workers.[1,7–9] Workplace safety standards adopted in WA and California focus on hydration, rest, acclimatization, clothing, emergency plans, shade, and education, including education about personal HRI risk factors such as certain chronic conditions and the use of certain medications. In addition to these factors, formative studies in agricultural workers have described additional potential barriers to HRI prevention, including a long distance to the restroom, perceptions of water located near restrooms as potentially contaminated, and a perceived benefit of weight loss from sweating when wearing layers of clothing.[10–14] Piece rate pay, or payment per amount of work done, has been reported to increase injury risk through increased risk-taking behavior and fatigue[15] and may also influence HRI risk by incentivizing increased exertion and fewer breaks for rest, hydration, and restroom use.

Although a number of studies have sought to characterize HRI in agricultural workers using survey approaches,[16–19] no study has identified HRI risk factors in crop workers using a survey with published validity and reliability characteristics. Without such evaluations, the extent of misclassification due to information bias, and its impact on the interpretation of results, is unclear. Further, studies indicate that audio computer-assisted self-interview (A-CASI) instruments, which consist of narrated questions and answer choices with visual aids, are efficient in field settings, effective in low-literacy populations, do not suffer from interviewer bias, and lead to more accurate self-reports of sensitive information when compared with surveys administered by trained interviewers.[20,21] The aim of this descriptive study was to identify risk factors for self-reported HRI symptoms in WA crop workers, who are largely Spanish speaking, using an A-CASI instrument that has undergone reliability and validity evaluation. The hypothesis was that, in addition to "traditional" risk factors, including personal risk factors, clothing, hydration, acclimatization, and environmental factors, other modifiable workplace factors, such as those related to workplace water and restroom characteristics and payment schemes, are associated with exertional HRI in this population.

METHODS

Survey Development and Evaluation

Survey topics were identified using information obtained from a literature review, analyses of WA workers' compensation HRI claims,[3] and focus group sessions with WA crop workers.[13] Survey topics included work history and current work activities; work payment methods; breaks and hours typically worked; work exertion, hydration, cooling methods, and clothing; health and HRI symptoms; medications, alcohol and tobacco use; level of concern about workplace heat exposure; and HRI training.

Survey questions were adapted from existing validated surveys when possible, modeled after questions from a validated A-CASI survey instrument designed to identify risk factors for cholinesterase depression in agricultural pesticide handlers in WA,[22] or developed by the research team when previously used, validated survey questions were not available. Assessment of workplace exertion was adapted from the Borg and OMNI Rating of Perceived Exertion scales.[23–25] Draft questions were developed in English and then translated into Spanish and audiorecorded by bilingual and bicultural project staff members. Questions about factors that change over time, such as work tasks and activities, asked about the past week to minimize recall bias. In other contexts, 1-week recall questions have yielded reliable and valid results.[26–28]

The survey was developed using Open Data Kit (http://opendatakit.org/), a freely available platform for Android devices. The survey included Spanish and English narrations of questions and photographs and illustrations, which were designed to be vivid and realistic, characteristics that have been shown to facilitate understanding in low-literate, Latino farmworkers.[29] A group of six crop workers representative of the study population evaluated the survey instrument for content validity and usability. The survey was iteratively revised based on this feedback and suggestions from collaborators at Oregon State University, who adapted the survey for use in a separate study of agricultural workers.[19] The final survey instrument consisted of 64 items.

Seventeen outdoor crop workers from one WA orchard participated in concurrent validity and test-retest reliability evaluation of the survey during the summer of 2013. These workers were observed by trained research staff, who recorded observations on clothing, the type and quantity of beverages consumed, how workers cooled themselves (e.g., sitting in the shade), when workers started and ended their work days, durations of employer-mandated and self-initiated breaks, and descriptions of tasks, during 4 workdays on standardized forms. Three of the 4 days occurred within 1 week, and observational data collected on these days were used for validation analyses. Body mass index (BMI) was calculated from measured height and weight as (weight[kg]/height[m]^2). Project staff members assigned work tasks to exertion categories based on the American Conference of Governmental Industrial Hygienists (ACGIH) Heat Stress Threshold Limit Value (TLV) metabolic rate categories[30] and project staff consensus, with exertion ranging from "light" to "very heavy." Demographic characteristics, work activities, and certain health characteristics that were not expected to vary over time were selected for reliability evaluation (Appendix 1, see Supplemental Data). Questions that asked about activities or behaviors that were not observable at the workplace, such as medication use and chronic health conditions, were not evaluated for validity. Participants who were observed took the survey on the first and last days of observations (spaced 15 days apart).

Concurrent test-retest reliability and validity statistics (percent agreement and kappa coefficients) for survey responses are shown in Appendices 1 and 2, respectively. In general, survey questions covering demographics, health status, health conditions, training, health behaviors, and HRI appeared to be reasonably reliable (% agreement 71–100% or kappa 0.70–1.00, comparing participant responses at each survey administration day). Survey questions assessing work tasks, times, payment schemes, types of beverages consumed, workplace shade, and certain clothing questions demonstrated acceptable validity (% agreement between survey responses from the first survey administration day and field observations 71–100%).

Participant Recruitment and Survey Administration

Adults engaged in outdoor, summer crop work in Central or Eastern WA were eligible to participate in the study. During the summer of 2013, bilingual and bicultural project staff members, who reside in Central and Eastern WA, contacted local orchard and farm supervisors and individual crop workers. Sampling was not random; research staff contacted growers and workers whom they felt were likely perform outdoor summer crop work. Research staff asked for permission from employers to recruit workers at their workplaces. Project staff traveled to workplaces or mutually agreed upon meeting locations, explained the goals of the project, and asked eligible workers if they were interested in participating. Interested participants provided informed consent.

The survey was administered on touch screen tablets (Asus Eee Pad Transformer Prime 10.1 inch screen; ASUS Computer International, Fremont, CA, USA) to 100 participants from nine workplaces (median [range] of 6 [2–28] participants per workplace) in Central and Eastern WA from July 2013 through September 2013. Twenty of these participants were additionally recruited to participate in the previously described reliability and validity studies (2 dropped out in the middle of the study, and 1 did not complete the first survey, leaving 17 for the reliability and validity analyses). Comparisons between the full participant group ($N = 97$) and the observation participants ($n = 17$) are shown in Appendix 3 (see Supplemental Data). The University of Washington Institutional Review Board approved all study procedures.

Outcome and Potential Risk Factors

The outcome was defined a priori as self-reported HRI symptoms (dizziness/light-headedness or heavy sweating, versus none of these symptoms, during a hot day at work in the past week). The survey asked about specific symptoms, as participants were not assumed to know which symptoms were associated with heat strain or HRI. This a priori combination of specific symptoms was used as a single outcome variable in the analyses. The outcome definition (light-headedness/dizziness or heavy sweating) focused on symptoms that are both symptoms of HRIs and also reflect underlying physiological mechanisms that, when overwhelmed, can lead to heat stroke. Increased cardiovascular demands and heavy sweating (particularly without adequate fluid replacement) can lead to inadequate delivery of blood to the tissues and associated symptoms of light-headedness/dizziness, less efficient evaporative and convective heat loss, and a rise in core body temperature.[31] Symptoms of light-headedness/dizziness and heavy sweating are also associated with heat syncope and heat exhaustion. Of note, although fainting was included in the original outcome definition, no workers reported fainting. Heat rash, cramps, headache, fatigue, and nausea/vomiting were reported (Appendix 3) and can also be associated with HRI, but these symptoms were not included in the outcome definition because they are often caused by other illnesses and may not be directly related to underlying physiological mechanisms of interest. Dizziness/light-headedness can occur as a result of hypoglycemia in diabetics, particularly those taking certain diabetes medications. However, none of the participants that reported dizziness/light-headedness during a hot day at work reported being told by a health provider that they had diabetes. Reactive and fasting hypoglycemia is rare in nondiabetics, particularly those that are relatively healthy.[32]

Potential HRI risk factors in the following domains were selected a priori for inclusion in the risk factors analysis based on the existing scientific literature: (1) demographic; (2) HRI training in the past year; (3) work factors; (4) hydration; (5) clothing; (6) health; and (7) environmental conditions. Preference was given to potential risk factors for which corresponding survey questions had acceptable performance in reliability and validity evaluations (Appendices 1 and 2). The variables included in the risk factors analysis are shown in Table 1.

Hourly temperature and relative humidity data were obtained from Washington State University's AgWeatherNet weather station program[33] and were used to calculate hourly heat indices using standard methods,[34,35] as previously described.[3] Maximum daily heat indices for self-reported work hours for each participant were used to compute mean maximum daily heat indices over the past week (HI_{max}), as the past week was the duration of recall of most survey questions.

Analyses

Ninety-seven participants' responses were included in the analyses. Of the 100 participants to whom the survey was administered, 3 participants' responses were excluded from the descriptive analyses because they did not complete the survey ($n = 1$) or they indicated that they did not work during the preceding week ($n = 2$), the time frame asked about in the majority of the survey questions.

Separate mixed-effects logistic regression models, with random effects for workplace, were constructed for each domain of risk factors. All variables were coded as categorical variables, as shown in Table 1, except age (years), HI_{max} (°F), and BMI (kg/m^2), which were coded as continuous variables, in regression models. Variables with a P value $<.50$ in single-domain models were entered together into a multidomain mixed-effects logistic regression model, with a random effect for workplace, of HRI. Statistical analyses were performed using Stata 10 (StataCorp, College Station, TX, USA).

TABLE 1. Potential HRI Risk Factors by HRI Status (Percent or Mean [SD])

Potential risk factor	No HRI ($n = 67$)	HRI ($n = 30$)	Total ($N = 97$)
Demographic			
Age (years)	43 (13)	36 (13)	41 (13)
Male (vs. female)	55	47	53
Training			
No HRI training (vs. HRI training)	65	70	66[a]
Work factors			
Piece rate pay (vs. hourly pay)	42	67	49
No extra breaks (vs. extra breaks)	22	24	22[b]
Hard/very hard work (vs. light/medium work)	17	23	19[c]
>3 minutes' walk to toilet (vs. <3 minutes)	29	47	34[c]
Hydration			
Drank caffeine[d] (vs. did not drink caffeine)	31	37	33
Drank less than every 30 minutes (vs. drank every 30 minutes or more often)	42	45	43[c]
Clothing			
No light-colored shirt (vs. light-colored shirt)	24	23	24
Health			
Body mass index (kg/m^2)	28 (4)	28 (5)	28 (4)[e]
Good/fair general health (vs. excellent/very good health)	67	77	70
Diabetes mellitus and/or antihypertensive medication use (vs. no diabetes and/or antihypertensive use)	27	21	25[f]
Environmental conditions			
Mean maximum daily heat index (°F)	84 (2)	83 (2)	84 (2)

Note. HRI = heat-related illness, defined as self-reported dizziness/lightheadedness or heavy sweating during a hot day at work in the past week.
[a]Two observations missing.
[b]Four observations missing.
[c]One observation missing.
[d]Energy drinks, coffee, or soda.
[e]Three observation missing.
[f]Nine observations missing.

RESULTS

Participant Demographic Characteristics

Characteristics of the study population are shown in Table 1, and additional details are shown in Appendix 3 (see Supplemental Data). The majority (91%) of participants were born in Mexico, and nearly all identified as Latino/a. The mean (standard deviation) age was 41 (13) years, 53% of participants were male, and over half of participants reported only a primary school education. Fifty-nine percent and 11% of participants reported being able to read very well in Spanish and English, respectively. The majority of participants reported working with tree fruit, and common tasks included harvesting and thinning green fruit.

Health and HRI Symptoms

The mean (standard deviation) BMI was 28 (4) kg/m^2. Thirteen percent of participants reported that a health care provider has told them they have diabetes, and 12% reported taking medications for hypertension in the past week. Approximately one third of participants reported experiencing HRI symptoms (lightheadedness/dizziness or heavy sweating) during a hot day at work in the past week. Ninety percent of participants reported starting work for the season at least 3 weeks before the survey, and the mean (standard deviation) number of days worked in the past week was 4.9 (1.5), indicating that most participants were likely acclimatized to the Central/Eastern Washington outdoor summertime environment.

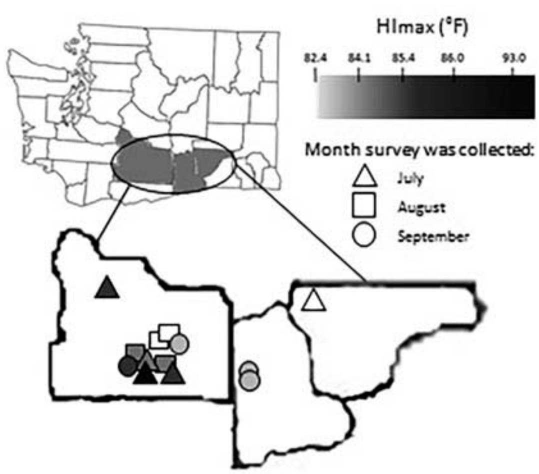
Work Factors, HRI Training, and Environmental Conditions

Seventy-four percent of participants reported feeling that they were allowed to take extra breaks if needed to rest or drink water. Approximately one third of participants reported usually having to walk for more than 3 minutes to get to the toilet. Only about one third of workers reported receiving training about working outdoors in the heat or health effects of working in the heat in the past year. Approximately half of the participants reported being paid by the piece. The mean (standard deviation) HI_{max} during reported working hours was 84°F (2°F). The temporal and geographical distribution of HI_{max} during the study period is described in Figure 1. During the study period, the maximum daily temperature ranged from 77°F to 97°F. Mean temperatures in July and August in Central/Eastern Washington area are typically in the 70s °F.[33]

Hydration and Cooling

Workers reported drinking water (96%), including water brought from home and provided at work, soda (31%), sports drinks (23%), juice (8%), energy drinks (6%), and coffee or tea (4%) at work. Fifty-seven percent of workers reported usually drinking water every 30 minutes or more in the past week. The majority (92%) of workers reported access to shade from trees at work. Nearly all workers reported wearing some type of head covering, over three quarters of participants reported wearing a light-colored shirt, and 13% reported wearing some type of personal protective equipment (3% Tyvek or chemical resistant suits; 1% respirator) at work in the past week.

FIGURE 1. Spatiotemporal distribution of HI_{max}, the mean maximum daily heat index over the week prior to survey completion, the duration of recall of most survey questions.



Risk Factors for HRI Symptoms

Participants reporting HRI symptoms (lightheadedness/dizziness or heavy sweating) in the past week, compared with participants who did not report HRI symptoms, were more likely to report being female, not having HRI training the past year, being paid by the piece, not feeling that they were allowed to take extra breaks to rest or drink water, working harder, having a greater distance to walk to the toilet, drinking caffeine, drinking less frequently, and having good or fair (versus excellent or very good) general health (Table 1). The mean (standard deviation) age was lower in participants reporting HRI (36 [13] years), compared with participants not reporting HRI (43 [13] years), and participants reporting HRI were less likely to report being told by a health care provider they had diabetes or using antihypertensive medications.

Results from the final multidomain mixed-effects logistic regression model are shown in Table 2. An increase in age was associated with a lower odds of HRI (odds ratio [OR] = 0.92; 95% confidence interval [CI] = 0.87–0.98). Piece rate compared with hourly pay (OR = 6.20; 95% CI = 1.11–34.54), and needing to walk for more than 3 minutes to get to the toilet, compared with less than 3 minutes (OR = 4.86; 95% CI = 1.18–20.06), were associated with a higher odds of HRI.

DISCUSSION

In this descriptive study, modifiable workplace factors, including a longer distance to the toilet and piece rate, versus hourly, payment, were associated with self-reported HRI

TABLE 2. Odds Ratios (95% Confidence Intervals) of HRI by Potential Risk Factor[a]

Potential risk factor	Odds ratio	95% confidence interval
Demographic		
Age	0.92	0.87–0.98
Male (reference: female)	0.75	0.22–2.59
Work factors		
Piece rate pay (reference: hourly pay)	6.20	1.11–34.54
No extra breaks (reference: extra breaks)	1.38	0.34–5.64
Greater than 3 minutes' walk to toilet (reference: less than 3 minutes)	4.86	1.18–20.06
Hydration		
Drank caffeine[b] (reference: did not drink caffeine)	0.49	0.11–2.30
Health		
Good/fair general health (reference: excellent/very good)	1.26	0.33–4.90
Diabetes mellitus and/or antihypertensive medication use (reference: no diabetes and/or antihypertensive use)	0.79	0.18–3.41

Note. HRI = heat-related illness.
[a]Final mixed-effects logistic regression model, with random effect for workplace, adjusted for all variables in table.
[b]Energy drinks, coffee, or soda.

in Washington crop workers. Although the risk of HRI is particularly high in tropical and subtropical areas of the world,[36] HRI can occur even in temperate climates when internal heat generation is substantial and clothing is not optimal[37] and indoors when effective cooling mechanisms are not available. In this study of outdoor crop workers, approximately one third of participants reported experiencing HRI symptoms (dizziness/light-headedness or heavy sweating) in the past week. There was no significant association between environmental conditions (HI_{max}) and the risk of HRI. This finding is not surprising given the contribution of other factors, including those that affect internal heat generation and acclimatization, to exertional HRI. In addition, although the study did encompass hotter work conditions than are typical on Central/Eastern Washington summer days, there was relatively little variability in environmental conditions during the study period.

Although previous studies have reported associations between piece rate pay and increased injury risk,[15] this is the first study reporting an association between piece rate, versus hourly, pay and HRI in crop workers. Economic incentives have been reported to motivate workers to labor harder and faster.[15] Increased exertion, and associated metabolic heat generation, may in part mediate the effect of piece rate pay on the development of HRI. Managers may choose piece rate pay to incentivize increased productivity for certain physically demanding tasks such as harvesting hard fruit. Although limited by a small sample size, adjustment for task and exertion in secondary analyses did not fully attenuate the association between piece rate pay and HRI symptoms, suggesting that there may be other effects of piece rate pay on the development of HRI symptoms. Further investigation is needed.

In validity analyses, self-reported exertion did not correspond optimally with observed exertion level (Appendix 2, see Supplemental Data). The task-based metabolic rate estimates used by field observers did not take into account personal characteristics that may affect metabolic rate, such as age and certain health conditions, or variation in procedures that involve different levels of physical exertion for a single task. Self-reported exertion using the Borg scale approximates heart rate in certain circumstances.[23] An adaptation of the Borg and OMNI Rating of Perceived Exertion[24,25] scales that was most accessible to the study population was used, as the original versions of these scales were felt to be difficult to interpret by participants in initial content validation and feedback sessions. Since metabolic heat generation is a key consideration when determining the risk of exertional HRI, these findings should be confirmed using objective measures to estimate metabolic rate, such as heart rate measurements and actigraphy. Such methods could also help distinguish between effects of metabolic heat production and environmental heat exposure, relationships that were not directly assessed in this study.

Piece rate pay may encourage taking less time for rest and hydration. Although not statistically significant, an increased risk of HRI among workers who reported that they felt they were not allowed to take extra breaks to rest or drink water, versus those who felt they could take extra breaks, was observed. Given the association between piece rate pay and adverse health and safety outcomes,[15] consideration should be given to more frequent mandatory breaks, separate pay for breaks, or transitions to hourly pay above a certain heat exposure threshold in these workers. The effects of such interventions on health and productivity, which is also affected by heat stress,[38] should be evaluated using objective methods in representative populations.

A longer distance to the toilet was associated with HRI in this study. In a post hoc analysis, no evidence of effect modification of the relationship between distance to the toilet and HRI by gender was present. These findings are consistent with previous reports that have identified properties of workplace restrooms, including accessibility and proximity to drinking water, as barriers to adequate hydration.[13,14] One approach to facilitate close proximity to restrooms involves hooking portable toilets up to vehicles that are moved to locations where workers are working. However, the movement of crop workers and work throughout the day can be complex, and movement of restrooms could pose logistical challenges. Additional analyses of objective data on the geographical locations of workers and restrooms at the worksite over time, for example using global positioning sensors, could be helpful in developing recommendations for optimal locations and movement of portable toilets.

An increase in age was associated with a lower risk of HRI in this study. Unlike classical heat stroke, which is more common in the elderly and very young, occupational HRI has been reported to occur in relatively young workers, particularly workers who generate metabolic heat from heavy physical labor in hot environments.[1,3] Although age was not significantly associated with exertion level, increased age was associated with working more seasons in agriculture. There was no assessment of whether experience itself might impart HRI preventive knowledge, as HRI knowledge was not assessed.

Over half of survey participants reported not receiving HRI training in the past year. Yet HRI training is required annually per the Washington Agriculture Heat Rule between May 1 and September 30 when outdoor agricultural workers are exposed to temperatures above 77°F to 89°F, depending on the type of clothing worn.[7] Whether the low prevalence of training was due to an actual low prevalence of training or workers not remembering, or not being aware of, having received annual HRI training was not assessed. Further evaluation of the prevalence and effectiveness of HRI training strategies that addresses barriers to HRI prevention and treatment in this population are needed.[13,14]

Although published studies have utilized self-reported hydration questions, including hydration frequency questions,[16–19] the validity of these questions has not previously been reported. Self-reported questions assessing the frequency of water consumption did not perform optimally on validity testing (Appendix 2), and validation of hydration frequency was difficult to perform using field observations. Self-reported hydration questions may also suffer from recall bias. Objective measures of hydration status, such as plasma and urine osmolality or urine specific gravity,[39] should be used in future studies if possible. Although not statistically significant, a reduced risk of HRI in workers who reported drinking caffeine was found. The role of caffeine in the development of HRI is controversial,[40] and it is possible that hydration, even with caffeinated beverages, is preferable to no hydration.

The clothing variable in the main analysis addressed whether or not a light-colored shirt was usually worn at work over the previous week. The analysis did not focus on pants, in part because previous research in tropical environments has indicated no difference in body temperature when comparing workers wearing shorts with those wearing pants.[41] Although the color of clothing is relatively easy to observe and may have some influence on heat transfer, other clothing characteristics that are important to consider were not captured, such as air flow and fabric type. Heat exchange, as it relates to clothing, is influenced by the insulating ability of the material, air movement, and relative humidity.[42] In general, detailed clothing characteristics and behaviors were difficult to validate using notes recorded by field observers. In future studies, photographs taken at the beginning and end of the work shift may assist in determining the type of clothing and whether or not layers were removed, a behavior that otherwise difficult to capture.

Limitations

This study has several important limitations. First, outdoor crop workers in WA were not randomly sampled. Participating workplaces may have been more likely to engage in HRI prevention, leading to an underestimate of HRI symptom prevalence. It is also possible that workers who participated are systematically different than all WA outdoor crop workers. Second, the HRI outcome and personal and workplace risk factors were self-reported. Risk factor analyses incorporating an outcome of heat strain estimated from core body temperature and heart rate, using established methods such as the Physiological Strain Index,[43] could provide further insight into HRI risk. In comparable populations, objective measures could complement survey questions that were determined to be reasonably reliable and valid in this study (Appendix 4, see Supplemental Data). Third, this study is cross-sectional and relatively small. There may not have been sufficient power to identify all HRI risk factors. Finally, the results of this study, which was conducted in Latino crop workers in WA, may not be generalizable to all crop workers.

CONCLUSIONS

In this descriptive study of Washington crop workers, decreased age (and less work experience), piece rate pay, and longer distance to the toilet were associated with self-reported HRI. Modifiable workplace factors should be considered in HRI prevention efforts that are evaluated using validated, objective measures in representative working populations.

ACKNOWLEDGMENTS

The authors would like to thank Shuliu Yuan in the University of Washington's Department of Statistics for her assistance with statistical analyses.

FUNDING

This work was funded by the US National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention; grant number: 2U54OH007544-11.

SUPPLEMENTAL DATA

Supplemental data for this article can be accessed on the publisher's website. The supplemental data includes Appendices 1, 2, 3, and 4.

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