Journal of Occupational and Environmental Medicine, Publish Ahead of Print

DOI : 10.1097/JOM.0000000000001639

Title: Outcomes of a Heat Stress Awareness Program on Heat-Related Illness in Municipal Outdoor Workers

Ronda B. McCarthy, MD, MPH[1,2] ; Frances S. Shofer, PhD[1]; Judith Green-McKenzie, MD, MPH[1]

1. Concentra, Waco, TX; University of Pennsylvania, Division of Occupational and Environmental Medicine, Department of Emergency Medicine.

2. University of Pennsylvania, Division of Occupational and Environmental Medicine, Department of Emergency Medicine.

Corresponding author and author responsible for proofs and reprints:

Ronda Brewer McCarthy, MD, MPH

3400 Spruce Street, Hospital of the University of Pennsylvania,

Department of Emergency Medicine

Ground Silverstein, Philadelphia, PA, USA 19105

Phone: (254) 722-0696 Fax (215) 614-0666.

E-mail: ronda_mccarthy@concentra.com

ronda.mccarthy@uphs.upenn.edu.

Financial Support: none

Conflict of Interest: all authors- none

Acknowledgement: Mariksa Hernandez, Employee Health Front Office Lead, for her tireless support of this research project.

Abstract

Introduction: Heat Stress is an occupational hazard. Exposed workers may suffer heat-related illness, disease exacerbation, increased injuries, and reduced productivity. Response strategies include mitigation policies and preparedness.

Methods: Frequency of heat-related illness and workers' compensation costs before and after implementation of a voluntary Heat Stress Awareness Program were evaluated retrospectively in outdoor workers from 2009-2017. The program consisted of training, acclimatization and medical monitoring as outlined in NIOSH's *Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments.*

Results: Of the 604 workers assessed, those with two or more risk factors reported a heat-related illness at greater frequency, which decreased after program implementation. Median workers' compensation costs decreased by 50%.

Discussion: Heat-related illness prevention programs can be effective in reducing the frequency and severity of these occupational injuries as well as associated costs.

Key words: Heat-related illness; heat exposure; medical monitoring; heat-related illness prevention programs; acclimatization; workers' compensation costs; supervisor and employee training; increased ambient temperature; climate change

Introduction

Heat stress is an occupational hazard. Unnecessarily, thousands of US workers suffer from heat-related illnesses (HRI) and dozens die annually due to exposure to hot environments while at work (OSHA, 2017). Workers exposed to hot environments have reduced productivity, increased susceptibility to work related injuries, exacerbation and poorer control of diseases such as diabetes and hypertension, and a host of HRI ranging from heat rash to potentially fatal heat stroke (Sarofim et al., 2016; Wu et al., 2014). From 1992 to 2016, the Bureau of Labor Statistics (BLS) has documented 783 worker fatalities and nearly 70,000 worker injuries resulting from heat exposure (BLS, 2016). Even so, the burden of occupational HRI and subsequent death is substantially underestimated due to lack of recognition and misattribution of symptoms to other illnesses (Sarofim et al., 2016; Luber and Sanchez, 2006). Unfortunately HRI is expected to increase in frequency and severity due to increasing temperatures worldwide (Smith et al., 2016; Anderson and Bell, 2011). The National Oceanic and Atmospheric Association has recorded increasing temperatures in the US and globally over the past century (NOAA, 2018). Indeed, the last three decades have measured warmer than any other decade since 1850 (NOAA, 2018). Clearly, there is a reasonable concern that there is and/or will be an increased risk for HRI in workers (Balbus, Malina, 2016; Sarofim et al., 2016; Knowlton et al., 2009).

Strategies towards protecting employees who work in hot environments have been recommended by various national organizations and are also being implemented by some employers. In 2016, the National Institute of Occupational Safety and Health (NIOSH) published its third revision of their *Criteria for a Recommended Standard, Occupational Exposure to Heat and Hot Environments,* which outlines training for, medical monitoring of, and research on worker populations exposed. This criteria document came out of the disaster recovery effort associated with the British Petroleum Gulf Oil Spill Response in 2010.

NIOSH used the lessons learned from the 739 HRI associated with this disaster, into practice and recommended strategies to protect workers (King, Gibbin, 2011).These strategies include employer HRI prevention programs such as worker and supervisor training on heat stress and HRI, the utility of first aid and emergency response to HRI, implementation of an acclimatization program, work site controls based on environmental data, and medical monitoring of exposed workers (NIOSH, 2016; OSHA 2017).

Three states have already implemented their own worker protection regulations. After a wave of worker deaths, (Jackson, Rosenberg, 2010) California, Washington and Minnesota adopted varying levels of specific HRI prevention mandates to protect workers through the State of California Department of Industrial Relations (CalOSHA), Washington Department of Labor and Industries, The State of Minnesota Department of Labor and Industries respectively (MnOSHA) (Cal/OSHA, 2006; Wa/OSHA, 2009; Mn/OSHA, 2009). However, even if states and workplaces do not have specific heat illness prevention mandates, they are still required to protect workers, as exposure to hot environments are recognized as an occupational hazard with a propensity for HRI that can cause serious physical injury or death, covered by the OSHA General Duty Clause (OSH, 1970). This overarching worker protection clause states that employers are required to provide a place of employment that is “free from recognized hazards that are causing or are likely to cause death or serious physical harm."

This study seeks to determine the outcomes of a voluntary Heat Stress Awareness Program in outdoor municipal workers exposed to subtropical humid climate in Central Texas. The study period is from 5/15/2009- 9/15/2017. The intervention was implemented in March 2011.

Study Background:

A Heat Stress Awareness Program (HSAP) was implemented for the municipal employees of a mid-sized Central Texas city in 2011 after anecdotal evidence suggested that outdoor workers employed at certain municipal departments were at risk for heat stress and heat-related illness (HRI). Departments with workers whose job descriptions specified work in hot humid environments with moderate to heavy physical demands were included in the Heat Stress Awareness Program. The departments that met this criteria were Streets and Traffic, Parks and Recreation, Utilities and Solid Waste. The fire department was excluded from the program due to the terms of the department's service agreement.

The HSAP consisted of training and medical monitoring of enrolled employees. Pre-placement and annual training program on heat stress awareness and HRI prevention was developed by the medical director for supervisors and employees. The HSAP was based on guidelines outlined in OSHA's *Heat Stress Technical Manual* and NIOSH's *Criteria for a Standard, Occupational Exposure to Heat and Hot Environments.* The Heat Stress Awareness Program consisted of specific recommendations to department supervisors and the Safety manager on heat stress and HRI recognition and prevention. These recommendations mirrored the OSHA's Technical Manual Chapter on Heat Stress and included: unlimited access to cool water or cold sports drinks close to work site; providing canopies or other access to shade; establishing provisions for acclimatization schedule for new workers or established workers returning from an absence during hot season; work/rest procedures so that exposure time to high temperatures and/or the work rate is decreased; specific procedures to be followed for heat-related emergency situations; first aid protocols for immediate aid to employees displaying symptoms of HRI in the field, and the ability to communicate to supervisor if help was needed. An integral part of the HSAP was the development of an acclimatization program for new workers, workers returning from HRI or absences of three or more days during hot season. The hot season is defined as May 15- September 15. Two Employee Health Service (EHS) nurses, personally trained by the Medical Director, disseminated training material to department supervisors and provided in-person training to each department.

The medical monitoring program was developed and supervised by the Medical Director. It was based on the NIOSH guidelines outlined in the *Criteria for a Standard, Occupational Exposure to Heat and Hot Environments*. NIOSH recommends medical monitoring of workers exposed at or above Recommended Alert Levels (RAL) (NIOSH, 2016). The subtropical humid climate in Central Texas consisted of average high temperatures of 95^0 F (35^0 C) with an average humidity of 43% to 83% during 2009 – 2017 (US Climate Data, 2019). Wet bulb globe temperature readings were not available for this volunteer HSAP, but the average summer high temperatures (Wunderground, 2019) (Table 1) and average humidity the workers were exposed to approximated or exceeded NIOSH's RAL. Texas experienced a weather deviation in 2011 with its warmest and driest on record (NOAA, 2011).

The medical monitoring of exposed workers was initiated with a *Heat Stress Awareness Medical Evaluation Questionnaire* which queried prior HRI, chronic illnesses, medications and body mass index (BMI) among other risk factors that place workers at greater risk for HRI. Depending on responses provided in the questionnaire the worker was scheduled for an evaluation and individualized HRI prevention counseling either with the medical director or the employee health nurse, or mailed a Heat Stress Awareness letter regarding risk factors and HRI prevention education prior to the hot season.

Workers medically monitored for increased risk of HRI at the EHS were given an OSHA Quick Card on Heat Stress, printed in English and Spanish, at the end of their clinic visit for personal reference at work. This OSHA Quick Card briefly outlined signs and symptoms of HRI, as well as preventive and first aid measures (OSHA, 2017). The department supervisor was notified of worker's ability to perform essential job requirements with or without accommodation in a heat stress environment. As updated educational resources became available from OSHA and NIOSH these were utilized in individualized training; for example, the OSHA-NIOSH Heat Safety Tool was introduced into supervisor and personalized employee training (NIOSH, 2019). This occupational safety and health tool provided by OSHA and NIOSH, available in Spanish and English, provides real time index and hourly forecast, specific to employers' and workers' location, allowing planning of outdoor work activities (NIOSH, 2019). A Spanish speaking EHS staff member was available for medical monitoring exams and injury/ illness evaluations for Spanish speaking employees.

Methods:

A retrospective analysis of workers' compensation data of HRI before and after the implementation of the HRI prevention program for at risk outdoor municipal workers was performed. The setting is a mid-size city in Central Texas in a subtropical humid climate. Yearly medical monitoring demographics for the exposed employees was kept in a confidential medical file located in the Employee Health Services.

From 2011 through 2017, a confidential, self-administered questionnaire assessing risk factors for HRI was distributed yearly during February and March to included departments. This allowed for medical monitoring prior to the hot season (May 15- September 15). The questionnaire identified the following risk factors: body mass index, medications, chronic illnesses, alcohol and energy drink use, history of prior HRI, work in a second hot job and extensive skin pathology. Using these risk factors, workers were categorized into four HRI risk groups with the following protocols implemented:

1. Group N: No increased risk. Workers were sent results of questionnaire and information reinforcing heat stress and HRI prevention education.
2. Group M: Minimal increased risk. Workers with one risk factor (such as hypertension or BMI>30) were asked to report to EHS for a brief evaluation and counseling by EHS nurse. The worker's HRI risk factor was reviewed, vital signs taken, finger stick glucose if relevant and HRI prevention education was relayed to worker by the EHS nurse. An *OSHA Quick Card on Heat Stress and Heat-related Illness* was dispensed for each visit. The worker was referred to the onsite physician by the nurse if an unstable health risk for HRI was identified.
3. Group C: Concerning increased risk. Workers reporting two or more risk factors for HRI were offered medical monitoring examination, individualized HRI prevention and informal first aid training with the onsite physician.
4. Group U: Unstable health condition. Workers with an unstable health condition and a more immediate risk for HRI were restricted from work in hot environments by the onsite physician until their health condition was managed. Workers placed in this category once able to return to work in a hot environment, were re-categorized as Concerning Risk (C) and offered additional clinic visits during hot season to monitor health status. .

Summary statistics, such as frequencies and percentages for categorical data or means and median for continuous data, were used to describe the population. To determine if HRI risk increased with increasing risk group or increasing BMI, Cochran-Armitage test for trend was used. To determine differences in cost per HRI, before and after implementation of the HSAP program, Wilcoxon rank sum test was used. To examine changes in HRI over the 9-year period (2009-2017), logistic regression grouped in three year increments was used. All analyses were performed using SAS statistical software (Version 9.4, SAS Institute, Cary, NC).

Results

A total of 604 workers participated in Heat Stress Awareness Program (HSAP) medical monitoring from 2011 through 2017. Workers were 96% male, 67% white, with a mean age of 44, range (19-70). Median years of service was 4.6, range (<1-37). Municipal departments included in the HSAP were utilities (35%), Parks and Recreation (22%), Streets and Traffic (22%), and Solid Waste (20%). From these departments, 63% of employees had three or more visits to Employee Health Services (EHS) for heat stress medical monitoring and individualized HRI prevention training. During the 9 year study period, 38 workers experienced 44 heat-related injuries HRI.

Workers with HRI were more likely to have two or more risk factors for HRI compared to the workers with no HRI (34% vs 19%, p=.019, Table 2). Increasing body mass index category did not show a significant increase in HRI compared to those without HRI (p=0.29, Table 3).

Workers' compensation costs per HRI decreased. The median cost incurred per illness was $208 after HSAP implemented compared to $416 per HRI in the prior two years (p=0.0009, Figure 1). Additionally, over the 9-year time span HRI significantly decreased (Figure 2). The odds of an HRI in 2015-17 decreased by 91% and 66% compared to 2009-11 and 2012-14 respectively (OR=.092, 95% CI: 0.034, 0.250 and OR=.338, 95% CI: 0.122, 0.936). The last two years of the HSAP review the municipality submitted no HRI workers' compensation claims.

Discussion

This study data revealed three salient points: workers' compensation costs went down by 50% per HRI, worker's with HRI had two or more identified risk factors and the total number of HRI cases decreased after implementation of the HSAP.

The reduction in cost per HRI may have been because those that did occur were less severe due to the intervention. Increased employee and supervisor awareness of the signs and symptoms of HRI, and when to report it, may have allowed earlier medical intervention and thus decreased workers' compensation costs. Obviously, decreased costs reflect an underlying reality of decreased morbidity and even mortality from the severe and potentially fatal illness.

After implementation of the HSAP, workers with two or more risk factors were offered medical monitoring, training and first aid measures tailored to their health condition. Accurate identification of workers at risk allows more efficient use of employer's resources in preventing these illnesses. Interestingly, a statistical difference was not found when the risk factor BMI >30 was factored alone for study period.

Over the course of HSAP the HRI rate per year decreased and by the last two years there were no reported HRI during the hot season in the cohort. This HSAP, consisting of simple and inexpensive measures appears effective and potentially lifesaving.

A strength of the study is that the program was administered by only one Medical Director which allowed for consistency. Although retrospective, this research used existing data that was recorded in real time. As such, recall bias regarding the presence or absence of symptoms was not an issue. The HSAP used the evidence based recommendations and guidelines developed by NIOSH. The screening questionnaire was based on the risk factors outlined in NIOSH's *Criteria for a Standard: Occupational Exposure to Heat and Hot Environments*. Further strengths are the study's population size and the seven year duration of the medical monitoring program.

Limitations of the study include employee turnover, the fact that the screening questionnaire was not validated and the fact that it was self-administered. However, all health data reported in the questionnaire was reviewed and confirmed by medical staff.

Conclusions

These findings contribute to the small but growing body of literature on strategies that have been found to be successful in reducing and preventing HRI. We found that training of supervisors and employees on HRI and its sequelae, training on workplace strategies that can be implemented to prevent HRI, determining employee fitness for duty prior to work in a hot environment and periodic medical monitoring may help decrease frequency of occupational HRI. The cost of workers' compensation claims can also be reduced. The reduction in HRI and associated workers' compensation costs were temporally related to the introduction of the HSAP. The study supports NIOSH's *Criteria for a Standard: Occupational Exposure to Heat and Hot Environments* promulgation into US law. Occupational HRI's toll on workers and employers is gaining recognition in this era of climate change as ambient temperatures continue to rise (NOAA, 2019) resulting in unmistakable changes to our way of life (Perkison W, et al., 2017; McCarthy R, et al., 2018) Effective meaningful and specific regulations to protect vulnerable workers are needed now. Proven heat illness prevention protocols can be targeted for populations extending beyond the outdoor worker to save costs, health and lives.

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Figure 1. Violin plots of cost incurred per heat-related illness case

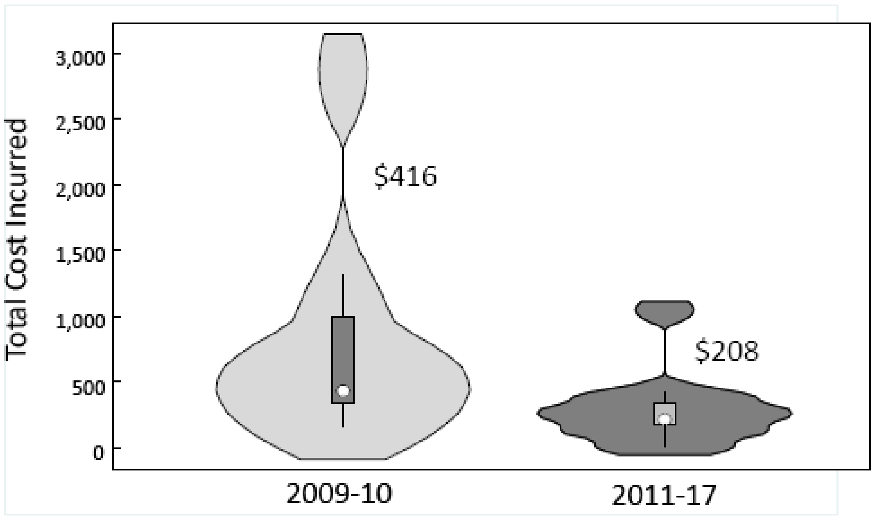

Figure 2. Heat-Related Illness Frequency Before and After Implementation of the Heat Stress Awareness Program

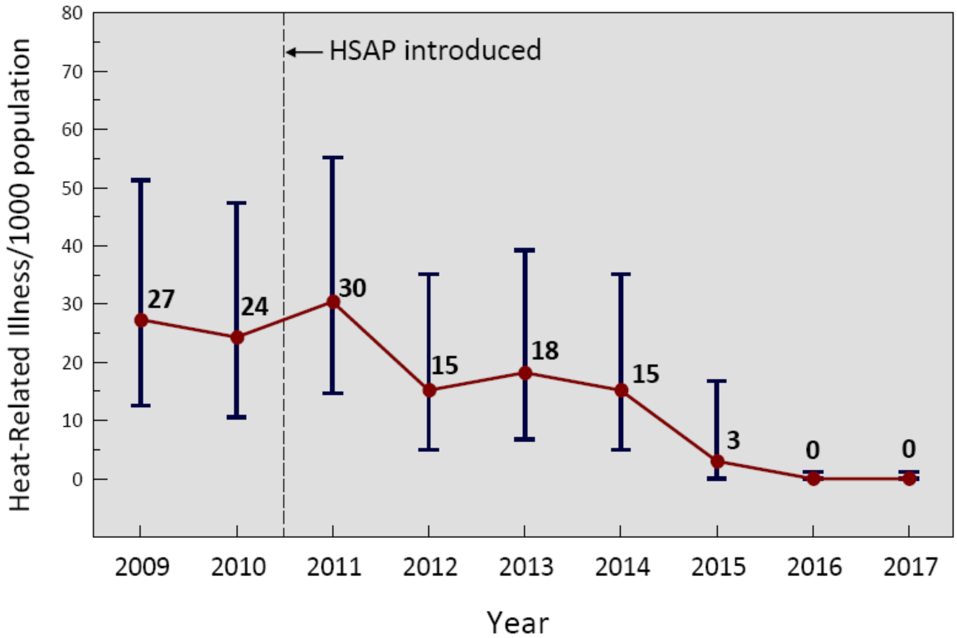

Table 1. Maximum and Average Temperature May – September 2009-2017 in Central Texas.

Year	Temperature in degrees Fahrenheit by Month									
	May		June		July		August		September	
	Max	Average	Max	Average	Max	Average	Max	Average	Max	Average
2009	94	86	106	98	103	99	104	100	101	87
2010	99	89	99	95	101	96	107	101	100	91
2011*	100	87	106	100	105	103	110	105	107	96
2012	96	89	107	96	104	98	105	98	103	90
2013	93	84	105	95	104	95	104	97	103	94
2014	91	84	94	90	100	94	102	98	99	91
2015	89	83	97	92	103	96	106	98	99	95
2016	92	82	98	93	103	98	105	94	99	91
2017	92	86	100	92	106	97	100	93	99	92

*Texas weather deviation in 2011-warmest and driest on record (NOAA, 2011).

Table 2. Comparison of Employees with and without Heat-Related Illness (HRI) by Risk Level

Risk Level (for developing heat-related illness)	No HRI		HRI	
	N (582)	%	N (38)	%
Normal: No increased risk	228	42%	10	26%
Minimal risk: one identified risk factor	211	39%	15	39%
Concerning risk ≥ 2 risks or prior HRI	105	**19%**	13	**34%**

Cochran-Armitage test for trend: p=.019

Table 3. Comparison of Employees with and without Heat-Related Illness (HRI) by Body Mass Index

Body Mass Index (BMI)	**HSAP (entire cohort)**		**HRI**	
	N (582)	%	N (38)	%
Normal: BMI 18-25	77	13%	6	16%
Overweight: BMI >25-30	219	38%	10	26%
Obese: BMI >30- 40	133	23%	7	18%
Severe Obesity: BMI >40	153	26%	15	39%

(Cochran-Armitage test for trend: p=0.29)