Outcomes for a Heat Illness Prevention Program in Outdoor Workers

A 9-Year Overview

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Objective: To describe the outcomes effect of removing the medical surveillance component from a heat illness prevention program (HIPP) for outdoor workers from a Central Texas municipality. **Methods:** Heat-related illness (HRI) frequency and workers' compensation (WC) cost were assessed retrospectively in a cohort of 329 workers from 2011–2019. During 2011–2017, the HIPP included training, acclimatization, and medical surveillance. In 2018–2019, a modified (mHIPP) was implemented that included training and acclimatization, but without medical surveillance. **Results:** The HRI rate during HIPP averaged 19.5 per 1000 workers during the first 4 years, dropped to 1.01 per 1,000 workers over the next 3 years, (2015-2017), and increased during mHIPP, to 7.6 per 1,000 workers. **Discussion:** Although the case increase during the mHIPP was small, medical surveillance may be an important component in lowering workforce HRI.

Keywords: heat-related illness, heat stress, medical surveillance, heat illness prevention programs, acclimatization, worker training, workers' compensation, OSHA

CME Learning Objectives

After completing this educational activity, the learner will be better able to:

- Describe the role of a medical surveillance program in heat illness prevention programs.
- Understand why heat stress is becoming an increasingly important problem in outdoor workers.
- Become familiar with the role of a medical surveillance program in heat illness prevention programs.

Interest in effective measures to prevent the health harms associated with exposure to hot environments increases as global ambient temperatures increase.[1] The National Oceanic and Atmospheric Administration reports record-breaking heat globally, with the 2010s being the hottest decade on record as of 2020.[2] Heat hazards impact both workers and employers resulting in decreased productivity and increased costs associated with accidents, heat illness, disease exacerbation, and worker death.[3,4] In the Pacific Northwest 2021 heat wave, Oregon and Washington had 22.4 times the states' reported heat-related deaths as compared with the year prior.[5] The fatalities were attributed to the heat wave bringing temperatures 30°F higher than average in late June 2021 for these two states. The Environmental Protection Agency also shows trends that indicate cities in Texas have had a significant increase in the number of heatwaves, an increase in the average duration of the heat waves, and an increase in the heat wave season duration between 1961 and 2019.[6] These heat waves lead to increased morbidity and mortality, especially in those with increased risk for heat-related illnesses (HRIs).[7]

Scientists believe that this trend will continue, leaving vulnerable populations, such as those with occupational heat exposure, at increased risk for poor health outcomes.[8] The changing climate affects millions of workers already exposed to dangerous levels of heat, thus adding to the thousands of known HRIs.

Research on reported OSHA work related HRI's has shown that nearly all fatalities occur when an important aspect of a heat stress prevention program is missing from the worksite.[9] Despite the importance of having comprehensive heat stress prevention programs, there are limited studies that measure the effectiveness of individual components of these programs in employee populations.[10] Moreover, there is not a current federal heat stress standard in place to protect workers from this increasingly common workplace hazard. As a result, in October 2021, the US Department of Labor's Occupational Safety and Health Administration published an Advanced Notice of Proposed Rulemaking for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings. The Advanced Notice of Proposed Rulemaking seeks to gather diverse perspectives and expertise on

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Ethical considerations: This study was approved of by the institutional review board at the University of Texas Health Science Center, Houston (IRB#HSC-SPH-21-0695).

We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for cohort studies.

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occupational heat exposure topics that OSHA can consider in developing the standard, including what controls might be required to reduce occupational heat-related injury and illness.[11]

This research is a continuation of a previous intervention study that demonstrated the value of an implemented standardized heat illness prevention program (HIPP) in municipal outdoor workers from 2011 to 2017, which demonstrated a reduction both in number of HRIs and their associated health care costs.[12] The HIPP program included three salient elements including the addition of (1) worker training related to heat prevention, (2) acclimatization protocols, and (3) medical surveillance (MS) program.[12] This study adds to our understanding of a MS program's impact on reducing HRI by including the subsequent 2 years (2018–2019) when the surveillance program ceased and a modified heat illness prevention program (mHIPP) continued that only included employee training and acclimatization.

STUDY BACKGROUND

Description of HIPP (2011–2017)

In 2011, the HIPP was implemented for outdoor manual municipal workers in central Texas municipality.[12] Heat illness prevention program was sourced from *NIOSH's Criteria for a Standard Occupational Exposure to Heat and Hot Environments*[13] and *OSHA's Technical Manual Chapter 4: Heat Stress*[14] and included department supervisor and employee *training, acclimatization procedures,* and *medical surveillance* implemented before the hot season of May through September.

Training included topics on heat stress management, HRI signs and symptoms, and HRI first aid and emergency response procedures. Provision of water and electrolyte fluids close to workers, shade, and opportunity to rest was also recommended. *Acclimatization* consisted of graduated exposure to heat as the seasons changed for existing employees. As a component of the HIPP, written acclimatization procedures were provided by the employee health clinic staff to the supervisors for an employee after postoffer physical and return to work evaluations during May through September. The NIOSH recommendations were used for new workers and written as 20% usual work duration in heat on day 1, adding 20% to the usual work duration in heat over a 5-day acclimatization period. For the employees returning to work after a heat-related illness or Family and Medical Leave Act absence during the hot season, acclimatization protocols were written for usual work duration at 50% on day 1, 60% on day 2, 80% on day 3, and 100% usual work duration in heat on day 4 and adjusted depending on the severity of HRI or duration of FMLA leave.[15]

Medical surveillance used a confidential, self-administered questionnaire assessing risk factors for HRI. The questionnaire was distributed during the postoffer preplacement examinations and annually each spring to at-risk employees in the departments with jobs meeting the criteria for at-risk workers. The questionnaire screened for factors that can increase the risk of an HRI including body mass index, certain medications, chronic illnesses, history of prior HRI, and others. Employees self-identifying one or more risk factors on the questionnaire were scheduled an appointment at the employee health clinic for further evaluation. Individualized heat illness prevention training based on personal risk factors was provided, and if indicated, recommendations for restrictions for work in hot environments. Employees with no identified risk factors were sent the results of the questionnaire and an education handout reinforcing heat stress symptoms, risks, and HRI preventive measures. The time period of HIPP, 2011–2017, is noted as "time period 1" in this article.

In 2018, description of mHIPP (2018–2019), as a result of increasing employee healthcare insurance costs, primary and wellness care was prioritized at the onsite employee health clinic, and the decision was made to not offer the heat stress MS program to workers but instead limit the program to include only required heat stress training to supervisors and employees in May of each year along with the seasonal acclimatization program for at-risk employees. Work-related illness and injury care continued to be provided at the onsite employee health clinic. Supervisors were also provided instructions on NIOSH's acclimatization schedules.[15] There was an administrative decision to discontinue the MS program and instead focus on primary care for the employees. Other than discontinuing the MS program and the subsequent work restrictions resulting from the surveillance all other aspects of the program were kept intact. Data were collected on HRI during mHIPP from its implementation until 2019. The 2-year time period of the mHIPP (2018–2019) is referred to as "time period 2" in this article. We are now looking at when the program changed to see whether there was a difference in outcomes.

METHODS

This is a retrospective observational study of municipal city employees working in a mid-sized city in Central Texas with subtropical humid climate during the two time periods. The inclusion criteria for the study remained the same as the first study—employees with a job description that includes outdoor work in extreme temperatures and medium to very heavy physical demands, based on the Department of Labor descriptions for these job types. This included the municipal department's Parks and Recreation, Streets and Traffic, Solid Waste, and Utilities. No other job descriptions in terms of demand were described for use by either the researchers or the employers. The Fire Department was again excluded due to a civil service agreement as in the original analysis. Heat-related illness frequency and associated workers' compensation (WC) costs were analyzed and compared for this cohort for both time periods 1 and 2.

Deidentified WC data from 2011 through 2019 provided demographics, costs, and heat-related illness data for the identified at-risk municipal outdoor employees. Results were stored in a secured, password-protected database. Heat-related illness frequency and WC costs were analyzed.

The analysis of WC data with and without the MS program included in the heat illness prevention measures for at-risk outdoor municipal employees was performed. Descriptive statistics for the cohort were calculated using means and medians for continuous variables and percentages and frequencies for categorical variables and compared between the two time periods. A Wilcoxon rank sum test was used to compare costs between time periods 1 and 2. All analyses were performed using R version 4.2.2 © 2022 (R version 4.2.2 [2022-10-31] Copyright © 1999–2023 R Core Team) statistical programming.[16] The study followed the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for cohort studies (Supplemental Table S1, http://links.lww.com/JOM/B503).

RESULTS

A total of 604 workers participated in the HIPP that included MS from 2011 through 2017. The city reported 360 positions annually in the five departments during the entire study period. Three hundred twenty-nine of these

TABLE 1. Descriptive Features of Municipal Employees Enrolled in Heat Illness Prevention Program

Municipality Description	HIPP (2011–2017)	mHIPP (2018–2019)
HRIs, *n*	27	5
Age, average, yr	41.8	43
Service time, average, yr	6.6	3.1
Cost, median (range), $	208 (8–1,682)	1078 (0–9,202)
Department, *n* (%)		
Parks and recreation	3 (11)	3 (60)
Solid waste	5 (19)	0
Streets and traffic	14 (51)	0
Utilities	5 (19)	2 (40)

HIPP, heat illness prevention program; HRI, heat-related illness; mHIPP, modified heat illness prevention program.

positions met the inclusion criteria. This number was used as the number of individuals exposed. Twenty-seven HRIs were reported by 24 individuals during time period 1, the comprehensive heat illness prevention program years (2011–2017). Five HRIs were reported by four employees during time period 2, the mHIPP years (2018–2019) (Table 1).

Description of the season from May through September in more detail in the Central Texas area (mean average temperatures recorded) for both time periods 1 and 2 part of the study are shown in Supplemental Table S2 (http://links.lww.com/JOM/B504).

Three of the individuals, who submitted HRI WC claims in the modified heat illness prevention program timeframe, also participated in the HIPP during its implementation. During time period 1, the 27 HRIs consisted of 3 (11%) in the parks department, 5 (19%) in solid waste, 12 (44%) in streets, 2 (7%) were in traffic, and 5 (19%) were in utilities.

The average age at the time of HRI was 41.8 years and the average years of service was 6.6 years during the HIPP program. During time period 2, the 5 HRIs consisted of 3 (60%) in the parks department and 2 (40%) in the utilities department. During the mHIPP period, the average age was 43.0 years, and the average years of service was 3.1 at the time of the HRI. All workers who experienced a heat-related illness from 2011 to 2019 were male. In time period 1, the costs for HRI events ranged from $8 to $1682 while the costs for 4 of the 5 HRI during time period 2 were $0, $208, $1947, and $9202. One of the 5 events was missing cost information. The median cost per HRI was $208 during time period 1 and $1078 during time period 2 (Fig. 1); however, this difference was not statistically significant ($P = 0.45$). The HRI rate during HIPP averaged 19.5 per 1000 workers during the first 4 years, dropped to 1.01 per 1,000 workers over the next 3 years, (2015–2017), and increased during mHIPP, to 7.6 per 1,000 workers (Fig. 2).

DISCUSSION

This study reports initial findings of HRI for a HIPP program during two time periods when medical surveillance was incorporated and then when it was removed. The median workers' compensation (WC) costs in period-2 were approximately 5 times the medical WC costs in period 1. However, the estimated cost of time period 2 includes an HRI that is an outlier from the other recorded HRIs, not related to "other" work related injury since no other illness/injury was documented and heat stress was the only diagnosis. Due to the small sample size, more surveillance and data collection is needed to determine whether this difference has significance. This data adds to research that measures the effectiveness of different components of heat stress prevention programs and specifically points to the importance of medical surveillance. While heat stress illness rates have been well documented in a variety of industries, our study is unique in that it utilizes a pragmatic study design to study an actual heat stress prevention program for outdoor workers. Moreover, the study provides a template for how small to medium sized employers can administer effective heat stress prevention measures and the potential added benefit of including medical surveillance as key component of that program.

Medical surveillance, as part of an HIPP, has the potential to increase employees' awareness of their individual risk factors. The MS evaluation is an opportunity to provide preventive measures specific to the employees' individual risk factors and check control of applicable medical conditions. For uncontrolled medical conditions, work restrictions limiting heat exposure can be placed until the medical condition is in control. Under Title 1 of the Americans with Disabilities Act of 1990, employees are protected if they are qualified to perform the essential functions of the job, when a reasonable accommodation is determined to be necessary to protect the employee's physical safety.[17] The OSHA can add this outcome data when considering effective heat illness prevention interventions for the proposed heat standard.[2]

Limitations of the study include the small number of workers included in the study, the short time frame of the measured mHIPP to only two years, and the fact that the WC data from the mHIPP period was missing one associated cost. The short mHIPP study period was limited in part due to the impact of the SARS-CoV-2 pandemic and the subsequent discontinuation of the employee health clinic in 2020 which resulted in the further reduction of the scope of employee heat stress surveillance programs. The total sample size was small and

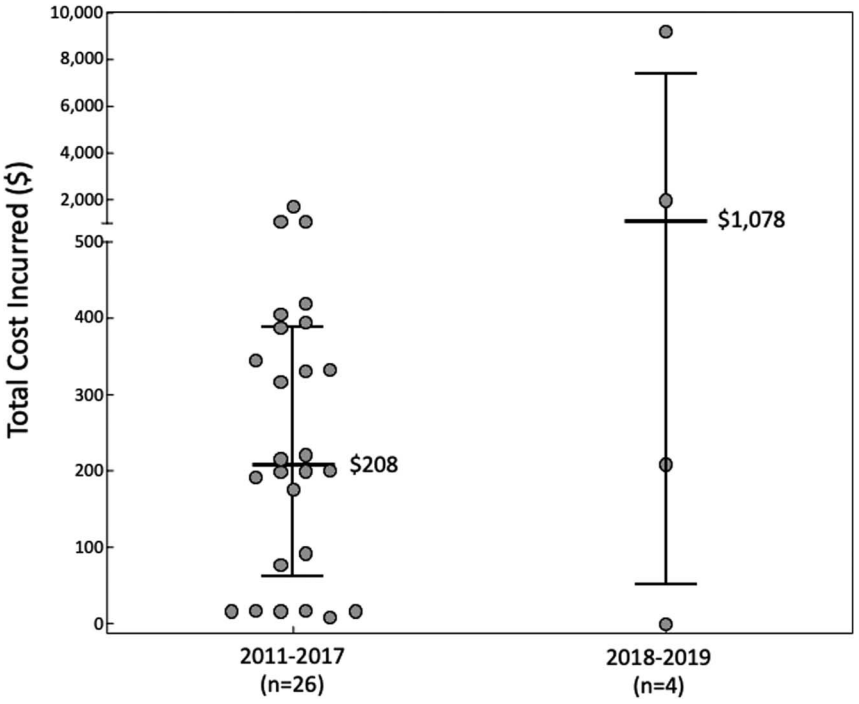

FIGURE 1. Cost of HRIs for time period 1 and time period 2.

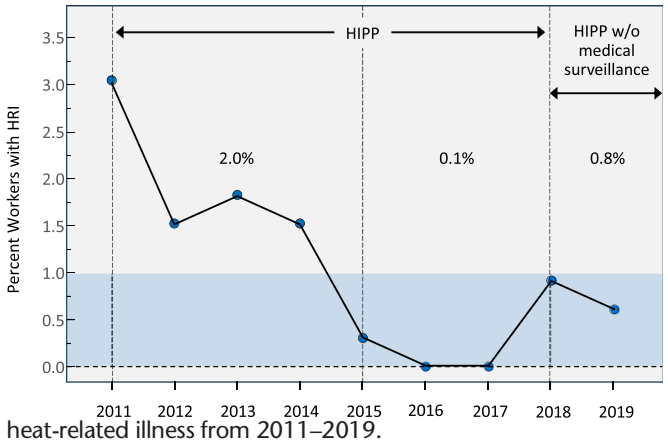

FIGURE 2. Percent workers with heat-related illness from 2011–2019.

the number of heat illness cases were low during both period 1 and period 2 and statistical significance was not achieved between the two periods in terms of the difference in both cost and the number of HRI. A longer period of observation in period 2 could help with this issue. However, this study contributes important information to the literature as it is one of the few pragmatic studies that includes analysis of an actual heat stress program with and without a medical surveillance program, and that captures WC costs. The average number of work hours spent outside for each department was not documented. However, for all of the groups evaluated, more than 90% of these department's time is spent outside. The standard work week is 40 hours, Monday–Friday, and overtime, which may be part of all of these department's requirements. They are also on call and may respond to after-hours emergencies. *Strengths* of this study include the long duration of the HIPP and recorded objective data obtained from WC records. While previous occupational research has examined the effectiveness of heat stress prevention measures in workers, the current study is the first to report the outcomes of preventive measures on HRI and WC cost in a cohort of outdoor workers for nearly a decade. Selection bias was not an issue because none of the individuals who had a heat stress illness in time period 2 has a documented heat illness in time period 1. Because of the fact this was a cohort of workers, these workers were in both time periods and were not excluded in any way.

While efficacy studies of heat stress prevention interventions in a controlled test environment are a necessary part of assessing the validity of an intervention it is also important to assess its effectiveness in actual work environments, including work groups of varying size, urban versus rural and other demographic variables. Future research in indoor manufacturing, construction, and agricultural industries is needed to generalize the results for other at-risk populations. The heat-related illness and injury prevention measures should be studied over other climates and industries to generalize findings to benefit all at-risk workers exposed to hot environments.

CONCLUSIONS

In this study, reported heat-related illness frequency and associated WCs cost were retrospectively analyzed in a cohort of Central Texas outdoor municipal workers with physically demanding work. Our objective was to assess these two measures from 2011 to 2017 when a comprehensive HIPP that included employee training, acclimatization, and MS was in place for the at-risk workers and again in 2018–2019, with a mHIPP in place that included training, acclimatization, without MS.

The health and safety dangers associated with occupational exposure to heat and hot environments are an imminent concern with the increasing ambient temperatures.[18,19] The current study observed data indicating the 2011–2017 HIPP's effectiveness that included recommendations outlined by OSHA and NIOSH.[13,14] The analysis of HRI frequency and associated WC costs during the HIPP and after discontinuing the medical surveillance program mHIPP suggest that medical surveillance is a critical program component as it assesses employee risk and allows work assignment accordingly. Employers must consider the costs benefit ratio of a heat stress medical surveillance program towards a reducing HRI and WC costs associated with illness, injury and exacerbation of chronic illness, not to mention the burden of human suffering. Preventing injury and illness to recognized hazards may be non- quantifiable to the employee, as employees' health, safety, and life is unmeasurable.

Clinical and Public Health Significance

Effective HRI prevention measures impact clinical practice and public health. Successful measures to mitigate the health harms associated with exposure to hot environments in occupational populations can be extrapolated to other vulnerable populations. Physicians should be able to understand and identify factors associated with increased risk for HRI and vulnerable populations.[20] Acute and chronic exposure to excessive heat is associated with new kidney injury and exacerbation of other chronic diseases such as cardiovascular diseases, asthma, chronic obstructive pulmonary disease, and diabetes.[13,20,21] Once identified, physicians can educate the at-risk patient on their individual risk factors and HRI preventive measures, the signs and symptoms of HRI, and the importance of first aid and emergency response procedures.

This research suggests that the MS component of this program has the potential to reduce the incidence, cost, and severity of HRI, while also enhancing medical provider awareness and report of heat stress.

Traditional public health surveillance approaches do not adequately capture the true impact of heat-related illness, especially in the occupational setting.[7,14] Local health departments are tracking very limited reports of heat related illness using *International Classification of Diseases, Tenth Revision,* codes such as excessive natural heat (X30), which is reported by medical providers. This research suggests that the MS component of this program is essential to reduce incidence, cost, and severity of HRI and has the potential to increase medical provider awareness and reporting of heat stress. This reporting leads to more robust data for public health to make better decisions for outreach and targeted interventions in the general population.

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REFERENCES

1. Romanello M, McGushin A, Di Napoli C, et al. The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future. *Lancet* 2021, 2021;398:1619–1662.
2. National Oceanic and Atmospheric Administration. (2020) Was the second hottest year on record for Earth say NOAA, NASA. Available at: https://www.noaa.gov/news/2019-was-2nd-hottest-year-on-record-for-earth-say-noaa-nasa. Accessed March 3, 2023.
3. Occupational Safety and Health Administration. Heat exposure Available at: https://www.osha.gov/heat-exposure. Accessed July 15, 2022.
4. Somanathan E, Somanathan R, Sudarshan A, Tewari M. The impact of temperature on productivity and labor supply: evidence from Indian manufacturing. *J Polit Econ* 2021;129:1797–1827.
5. Washington State Department of Health, Heat wave 2021. Available at: https://doh.wa.gov/emergencies/be-prepared-be-safe/severe-weather-and-natural-disasters/hot-weather-safety/heat-wave-2021. Accessed March 3, 2023
6. US EPA: Climate change indicators: heat waves | US EPA. (n.d.) Available at: https://www.epa.gov/climate-indicators/climate-change-indicators-heat-waves. Accessed August 2022.
7. Roelofs C. Without warning: worker deaths from heat 2014–2016. *New Solut* 2018;28:344–357.
8. Vargas Zeppetello LR, Raftery AE, Battisti DS. Probabilistic projections of increased heat stress driven by climate change. *Commun Earth Environ* 2022;3:183.
9. Tustin AW, Cannon DL, Arbury SB, Thomas RJ, Hodgson MJ. Risk factors for heat-related illness in U.S. workers: an OSHA case series. *J Occup Environ Med* 2018;60:e383–e389.
10. Morrissey MC, Casa DJ, Brewer GJ, et al. Heat safety in the workplace: modified Delphi consensus to establish strategies and resources to protect the US workers. *Geohealth* 2021;5:e2021GH000443.
11. Occupational Safety and Health Administration. (2021). Heat injury and illness prevention in outdoor and indoor work settings. Federal Register. 86 FR 59309
12. McCarthy RB, Shofer FS, Green-McKenzie J. Outcomes of a heat stress awareness program on heat-related illness in municipal outdoor workers. *J Occup Environ Med* 2019;61:724–728.
13. National Institute for Occupational Safety and Health (NIOSH). *Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments*. Washington, D.C.: DHHS (NIOSH) Publication No. 2016–106, February 2016; 2016.
14. Department of Labor. (2017) OSHA technical manual section III: chapter 4. Heat stress Occupational Health and Safety Administration, 2017. Available at: https://www.osha.gov/otm/section-3-health-hazards/chapter-4. Accessed May 20, 2021.
15. NIOSH, (2018) Heat stress acclimatization, workplace safety and health topics. Heat Stress Acclimatization. Available at: https://www.cdc.gov/niosh/topics/heatstress/default.html. Accessed July 2022.
16. R Core Team. *A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing; 2021.
17. Titles I and V of the Americans with Disabilities Act of 1990 (ADA). Available at: http://www.eeoc.gov/statutes/titles-i-and-v-americans-disabilities-act-1990-ada. Accessed May 10 2023.
18. Perkison WB, Kearney GD, Saberi P, et al. Responsibilities of the occupational and environmental medicine provider in the treatment and prevention of climate change-related health problems. *J Occup Environ Med* 2018;60:e76–e81.
19. Nabeel I, Caraballo-Arias Y, Perkison WB, et al, ACOEM Work Group on Mitigation/Adaptation Strategies Related to Climate Change. Proposed mitigation and adaptation strategies related to climate change: guidance for OEM professionals. *J Occup Environ Med* 2021;63:e650–e656.
20. Tustin A, Sayeed Y, Berenji M, et al, ACOEM Work Group on Occupational Heat-Related Illness. Prevention of occupational heat-related illnesses. *J Occup Environ Med* 2021;63:e737–e744.
21. Chapman CL, Hess HW, Lucas RAI, et al. Occupational heat exposure and the risk of chronic kidney disease of nontraditional origin in the United States. *Am J Physiol Regul Integr Comp Physiol* 2021;321:R141–R151.

