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Authors: Jacklitsch, Brenda L, King, Keith A, Vidourek, Rebecca A, and Merianos, Ashley L

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Heat-Related Training and Educational Material Needs among Oil Spill Cleanup Responders

Brenda L Jacklitsch^{id}, Keith A King, Rebecca A Vidourek and Ashley L Merianos

Health Promotion and Education Program, College of Education, Criminal Justice, and Human Services, University of Cincinnati, Cincinnati, OH, USA.

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ABSTRACT: Heat-related illness (HRI), injury, and death among oil spill cleanup responders can be prevented through training and educational materials. This study assessed heat-related training and educational materials currently used and desired by oil spill cleanup responders. A needs assessment was completed by 65 oil spill cleanup responders regarding their occupational heat-related experiences and training needs. Oil spill cleanup responders reported participating on average in 37 oil spill cleanup activities per year. Most reported experiencing additional HRI risk factors, such as high temperatures and humidity and wearing personal protective equipment and clothing ensembles, respirators, and personal flotation devices. Many reported experiencing symptoms of HRI (profuse sweating, headache, weakness, decreased urine output, high body temperatures) and experiencing heat exhaustion. Although multiple prevention controls were reported, only 1 in 4 reported using an acclimatization plan. The most common training delivery method and education received included just-in-time training and printed materials. The most desirable future training delivery methods and education products were smartphone or tablet applications, printed materials, and online training. Findings from this study may be beneficial to safety and health professionals and health educators, particularly those interested in developing heat stress training and educational materials for oil spill cleanup responders.

KEYWORDS: Heat stress, occupational, responders, health education

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CORRESPONDING AUTHOR: Brenda L Jacklitsch, Education and Information Division, National Institute for Occupational Safety and Health, 1090 Tusculum Avenue, MS C-10, Cincinnati, OH 45226, USA.
Email: BJacklitsch@cdc.gov

Introduction

Heat stress is a problem in many occupations, as it can result in illnesses and injuries during situations where the total heat load (environmental and metabolic) exceeds the abilities of the body to maintain the heat balance.¹ Heat balance occurs when there is equilibrium between body heat production and environmental gain and the heat loss to the environment. When heat balance is not maintained, heat-related illnesses (HRIs) and injuries can occur. The HRIs include heat stroke, heat exhaustion, rhabdomyolysis, heat cramps, heat syncope, and heat rash. Occupational heat-related injuries may occur from sweaty palms, fogged-up safety glasses, and dizziness or reduced brain function responsible for reasoning ability.¹

According to data from the Bureau of Labor Statistics (BLS),² there were 4190 annual cases of HRI and injury, resulting in 1 or more days of lost work among private industry and state and local workers. During that same time period, the BLS reported that 40 workers died from exposure to environmental heat. In California, there are heat-specific workplace regulations; however, HRIs and deaths still occur particularly in workers who are at additional risk (eg, extreme conditions, lack of knowledge, poverty, seasonality, low-level education, migratory status).³

Background

Many risk factors can contribute to heat stress and may be environmental or individual. Environmental factors occur in

the workplace setting and affect all employees, whereas individual risk factors affect each worker with variation. Environmental factors that place workers at elevated risk for HRIs include high temperatures and humidity, direct sun exposure or radiant heat sources and limited air movement.¹ Individual risk factors can include dehydration, physical exertion, personal protective equipment (PPE) and clothing, physical condition and health problems, medications, lack of acclimatization, and advanced age.¹

In an effort to address the continuing heat-related deaths, illnesses, and injuries in workplaces, NIOSH¹ published the *Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments*. This publication assessed the health hazards encountered in hot environments and recommended a standard to protect workers. In most cases, specific jobs and tasks involving heat exposure can be predicted in advance. Safety and health professionals and employers can lower the risk of heat stress by following the recommendations and creating a workplace heat stress prevention plan. Key elements presented in the document need to be addressed in most workplaces, but as workplace environments vary, some modifications are likely necessary for individual occupations.

The total heat exposure (metabolic and environmental) for workers should be controlled so that unprotected workers are not exposed to heat greater than the appropriate occupational exposure limit (OEL) based on acclimatization status of the



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workers.¹ The appropriate OEL can be selected by a safety and health professional; however, while using these OELs is ideal, for businesses that do not have safety and health professionals, establishing the required information can be daunting. In addition to OELs, a medical monitoring program (eg, preplacement and periodic medical evaluations) to prevent adverse health outcomes and identify HRI symptoms should be instituted for workers.¹

Training programs should be implemented for all workers and supervisors in areas where there is reasonable likelihood of HRI.^{1,4} Training should include heat hazards, risk factors, symptoms, and first aid.¹ Heat stroke, in particular, should be thoroughly discussed because the characteristics of the individual, type of activity, and symptoms vary between the classic and exertional classifications and the end result if not treated quickly is often death.⁵ Training should cover the effects of medications, alcohol, and caffeine that may reduce heat tolerance and increase risk. It may also be pertinent to offer refresher training, especially regarding symptoms, as some of the common public health messaging focuses on classic heat stroke, and workers are at higher risk for exertional heat stroke.⁵⁻⁷ In addition, workers should be included in discussions regarding cultural attitudes toward heat stress. For example, some workers might incorrectly believe that an individual can be “hardened” against the requirement for fluids by deliberately and regularly becoming dehydrated before work, and this type of misinformation needs to be replaced with easily digestible facts.^{1,8} Finally, heat stress may be reduced by implementing engineering controls or work practice controls.¹ These controls might include those that aim to increase air velocity, provide heat barriers, limit time in the heat and/or increase recovery time in a cool area, reduce the metabolic demands, institute a heat acclimatization plan, implement a buddy system and/or heat alert program, provide and encourage hydration breaks, and in certain situations, require workers to conduct self-monitoring.¹

A lack of training and preventive controls may elevate responders’ risk for HRI. A comprehensive review of the literature failed to identify published studies, which identified the training, and educational needs of oil spill cleanup responders. In addition, a paucity of studies have examined heat stress training and educational needs among individuals in other professions. Specifically related to oil spill responders, heat stress is well-documented as a major problem for emergency oil spill responders during large-scale oil spills.^{1,9,10} There were 978 heat stress incidents reported during the Deepwater Horizon oil spill response.¹⁰ The physically strenuous activities these workers were tasked with were amplified by the stressful situation and the demand to quickly complete the cleanup. Many responders also work long shifts while wearing PPE (eg, coveralls, boots, gloves) to protect themselves from the oil and chemicals used during cleanup, creating additional heat stress.¹ In addition, often these oil spill cleanup companies are small businesses, facing a lack of resources, greater time demands on managers, poor manager attitudes about safety, and fewer

employees to engage in activities such as safety committees.¹¹⁻¹⁵ As safety and health does not always take priority, small businesses are also burdened with higher injury and fatality rates than larger businesses.¹⁵⁻¹⁸

Study purpose

This pilot study was conducted as a means to inform researchers and employers about oil spill cleanup responders’ heat stress-related training and education needs, providing insights on prevention strategies and education for this at-risk population. Exposure to heat stress in an occupational environment, risk factors for HRIs, and possible preventive steps often create a complex world of possibilities that may be either protective or detrimental to workers. As the oil spill cleanup responder population is high risk for HRI, it may benefit from better-targeted and desirable training and educational opportunities. The following research questions were examined:

1. What is the current heat stress training provided to oil spill cleanup responders in various regions of the country?
2. Do type and duration of heat stress training in oil spill cleanup response situations differ based on number of years of experience, company size, employment classification, highest education achieved, and current climate region?
3. What heat stress educational products are currently used by oil spill responders?
4. What heat stress educational products do oil spill responders desire for use in an oil spill cleanup response situations?

Methods

Participants

A purposive convenience sample of oil spill cleanup responders in the United States was obtained through utilization of stakeholder networks and via an online directory of oil spill cleanup contractors. A pilot study sample of 440 potential participating companies was requested to participate, with 65 participants completing surveys.

Instrumentation

An online survey was developed to assess training and educational material needs and desires (Supplemental Material). A panel of experts was used to establish validity and consisted of those familiar with oil spill cleanup activities, heat stress, and/or survey design. The panel of experts were asked whether the questions were clear and understandable and if items measured what they were intended to measure. Along with demographics, basic work information questions asked whether participants were a safety and health professional, employer, or worker; years of employment in the oil spill cleanup industry;

within which state they currently work; and size of the company. The heat-related experiences section requested the number of cleanups/year, shift length, and number of breaks and included a list of heat-related experiences. Physical exertion was estimated using a question about level of activities during a shift. The section ended with a checkbox list of possible workplace heat stress preventive initiatives. A series of 5-point Likert scales were used for a list of statements relating to training and whether it is sufficient or whether there is a desire for additional training. Items were elements recommended by the NIOSH heat guidance document. There were also questions about the format of the received training and educational materials and the desire for certain formats.

Procedures

Oil spill cleanup companies across the United States were requested to participate. Company contacts were instructed that survey participants needed to be those who respond to oil spill cleanup activities. Contacts were sent a cover letter describing the purpose and the link to the online survey, via email. The survey remained open for 2 months. Participants arrived at the survey welcome page and were provided the purpose and assurance that responses were confidential. Surveys could be completed in approximately 15 minutes. Surveys in which most of the questions were left unanswered were eliminated from the study.

Data analysis

Data were exported into spreadsheets and recoded, as necessary. All data were analyzed using Social Sciences statistical software (SPSS). Frequencies, ranges, and percentages were used to describe demographics, employment information, previous heat-related experiences, activities, heat prevention controls, and training and educational materials. Means and standard deviations were used to describe heat stress-related training and educational materials received and training and educational materials desired. Due to this being a pilot study and the small sample size, the independent variables were dichotomized into the following categories: number of years of experience (24 years or less, 25 years or more), company size (1-19, 20 or more), employment classification (nonsafety and health professional; safety and health professional), highest education achieved (associate's degree or less, bachelor's degree, or higher), and current climate region (north/central, south/west). *T* tests were used to determine whether training received and training desired differed based on demographic variables.

Results

Demographics and work information

A total of 65 oil spill responders participated in the survey. Participants were mostly men (86.4%), white (93.3%), and

40 years or older (78.9%). Of these participants, the mean years of experience was 22.25 years (SD = 13.568), with 52.4% working 25 or more years and 47.6% working 24 or fewer years. Company size varied with 53.5% having 19 or fewer employees and 46.5% having 20 or more employees. Participants were classified as either being safety and health professionals (32.3%) or nonsafety and health professionals (67.7%). Regarding highest education achieved, 73.3% had a bachelor's degree or higher and 26.7% had an associate's degree or less. Concerning climate region in which individuals worked, 50.8% reported working in the northern or central regions and 49.2% reported working in the southern or western regions of the United States.

Previous heat-related experiences

On average, respondents reported participating in 37.52 oil spill cleanup activities per year (SD = 92.249), with the average length of the shift being 11.55 hours (SD = 5.855). During shifts, most reported either taking 2 to 3 breaks (44.6%) or 4 to 5 breaks (32.3%). Respondents reported experiencing high temperatures (>80°F [71.9%], >90°F [67.2%], >100°F [56.3%]), high humidity (85.9%), wearing PPE ensembles (96.9%), wearing a respirator (71.9%), and wearing a personal flotation device (78.1%). Nearly one quarter or more respondents reported experiencing the following HRI symptoms during oil spill response activities: profuse sweating, headache, weakness, decreased urine output, high body temperature and/or flushed skin, and dark urine (Table 1). The most commonly reported HRI and injuries reported were heat exhaustion, heat cramps, heat rash, and accidents related to fogged-up glasses (Table 1).

Work activities and heat prevention controls

Light (eg, sit/stand, slow walk, inspecting visually), moderate (eg, walking, surveying environment, working with hands and arms), and heavy (eg, handling lighter equipment, physically active) activities most often were reported to each occupy approximately 25% of the shift. Very heavy (eg, handling heavy equipment, very physically active strenuous work) activities were reported to take up 25% or less of the shift. Respondents reported that the following work-provided heat prevention controls were most often used: access to drinking water, heat stress training, buddy system, weather monitoring, shaded or cooled area for rest breaks, work/rest schedules, preplacement medical evaluation, and annual medical evaluation (Table 2). Half of the respondents reported mandatory "stop work" rules. The least often work-provided heat prevention controls were water-cooled or air-cooled garments/ vests and acclimatization plan.

Current and desirable heat stress training delivery methods

Respondents were asked about what current heat stress training delivery methods and educational materials they received

Table 1. Previously experienced heat-related symptoms, illnesses, and injuries during oil spill response activities.

	NO. (%)
Symptoms	
Profuse sweating	27 (41.5)
Headache	26 (40.0)
Weakness	18 (27.7)
Decreased urine output	17 (26.2)
High body temperature and/or flushed skin	17 (26.2)
Dark urine	16 (24.6)
Dizziness	14 (21.5)
Irritability	12 (18.5)
Heat rash	11 (16.9)
Cramps	8 (12.3)
Nausea	7 (10.8)
Confusion	3 (4.6)
Vomiting	3 (4.6)
Fainting	1 (1.5)
Seizures	0 (0.0)
Other	3 (4.6)
Heat-related illness	
Heat exhaustion	7 (10.8)
Heat cramps	4 (6.2)
Heat rash	4 (6.2)
Heat syncope	2 (3.1)
Heat stroke	1 (1.5)
Rhabdomyolysis	1 (1.5)
Other	1 (1.5)
Heat-related injuries	
Accident related to fogged-up glasses	4 (6.2)
Burns from hot equipment	2 (3.1)
Falls from dizziness	0 (0.0)
Other	1 (1.5)

N=65; percents refer to valid percents; missing values excluded.

(Table 3). Training received varied with most receiving just-in-time training and printed materials. Respondents were also asked what future heat stress training delivery methods and educational materials they desired (Table 3). Many were interested in a smartphone or tablet application, printed materials, and online training. Least desirable were more time-intensive half-day and all-day training.

Table 2. Previously work-provided heat prevention controls during oil spill response activities.

PREVENTION CONTROLS	NO. (%)
Access to drinking water	63 (96.9)
Training on heat stress	58 (89.2)
Buddy system	53 (81.5)
Weather monitoring	52 (80)
Shaded or cooled area for rest breaks	51 (78.5)
Work/rest schedules	47 (72.3)
Preplacement medical evaluation	44 (67.7)
Annual medical evaluation	41 (63.1)
Mandatory "stop work" rules	33 (50.8)
Water-cooled or air-cooled garments/vests	24 (36.9)
Acclimatization plan	17 (26.2)
Other	9 (13.8)

N=65; percents refer to valid percents; missing values excluded.

When comparing currently received heat stress training delivery methods and educational materials, a heat stress training score was assigned. This score was based on the variety of training that was currently taken with scores ranging from 0 to 8 (each item was worth one point). The more different training and educational materials currently received by survey participants, the higher the score. A similar training score was assigned for desired heat stress training delivery methods and educational materials. These overall scores were used in a series of *t* tests, which revealed that current and desired heat stress training did not differ significantly based on number of years of experience, company size, employment classification, highest education achieved, and current climate region (Table 4).

Discussion

Heat-related experiences

Overall, many of the respondents had work-related experience in the heat. Long shifts, in high temperatures and humidity, while wearing PPE can make heat stress a likely experience. These risk factors have been well-documented as attributing to the overall heat burden of individual workers and too often result in HRI.¹ Although most reported taking multiple breaks during a shift, many also reported experiencing common symptoms of HRI, therefore the breaks may not have been frequent enough or an adequate amount of time for the body to cool. Exertion is a contributing risk factor for HRI,¹ and with nearly 25% of their shift consisting of heavy work activities, this may indicate that more recovery time and/or hydration is needed. Along with the symptoms, the reported HRI and injuries are concerning and an indicator that additional training and education may be warranted.

Table 3. Heat stress training delivery methods and educational materials.

TRAINING/MATERIALS	RECEIVED	DESIRED
	NO. (%)	NO. (%)
Just-in-time training	42 (68.9)	10 (24.4)
Printed materials	31 (50.8)	21 (51.2)
Posters	28 (45.9)	13 (31.7)
Online training	27 (44.3)	19 (46.3)
Smartphone or tablet app	25 (41)	25 (61.0)
Half-day training with instructor	20 (32.8)	11 (26.8)
All-day training with instructor	15 (24.6)	6 (14.6)
Other	8 (13.1)	3 (7.3)

N=65; percents refer to valid percents; missing values excluded.

Table 4. Current and desired heat stress training received based on demographics.

	CURRENT				DESIRED			
	M	SD	T	P VALUE	M	SD	T	P VALUE
No. of years' experience								
24y or less	3.46	1.710	1.073	.288	2.55	2.089	-0.223	.825
25y or more	3.00	1.612			2.68	1.635		
Company size								
1-19	2.71	1.454	-0.451	.655	2.33	1.397	-0.356	.725
20+	2.95	1.810			2.55	1.635		
Employment classification								
Nonsafety and health professional	3.14	1.601	-0.484	.630	2.71	1.802	0.411	.683
Safety and health professional	3.37	1.862			2.46	1.898		
Highest education achieved								
Some high school through associate's degree	3.13	1.500	-0.206	.837	2.60	1.838	-0.068	.946
Bachelor's degree or higher	3.23	1.764			2.65	1.836		
Current climate region								
North/central	3.26	1.731	0.211	.833	3.16	2.141	1.764	.086
South/west	3.17	1.642			2.18	1.368		

N=65; Means based on heat stress training score with potential range of 0 to 8.

Results indicated that many heat prevention controls were used at the worksite. While mandatory "stop work" rules only existed in about half of the respondents' worksites, this is not surprising. Often oil spill cleanup activities need to be completed in a timely manner, despite weather conditions.⁹ Although water-cooled and air-cooled garments/vests were not often used, this may be attributed to the added cost, which for many small businesses can be deemed unnecessary.¹⁵ The

lack of an acclimatization plan being used for such a high percentage of participants was disappointing and indicates an opportunity for improving the heat stress prevention plan at many of these companies. Acclimatization consists of the physiological changes that occur in response to a succession of days of heat exposure and enables a person to work with greater effectiveness and with less chance of HRI.¹ When workers are not acclimatized, they may readily show signs of heat stress

when exposed to heat and have difficulty replacing water lost in sweat.^{1,5} Acclimatization has previously been identified as the program element most commonly absent and clearly associated with worker deaths when examining a series of HRI cases and associated heat prevention plans.¹⁹

Current and desired training delivery methods

Although a larger, more diverse, and robust sample could have identified potential variations in training and education needs, this pilot study provided some interesting results. Just-in-time training and printed materials were most often available for presenting information on heat stress. Such materials are commonly made available when there is an emergency situation resulting in little time but quickly obtained, effective training is necessary.²⁰ Many of the respondents were interested in future heat stress trainings that could be made available in digital form, such as smartphone or tablet applications and online training. This may be of growing interest, as more companies and individuals adopt use of portable electronic devices for worksites.²¹ The recently updated OSHA-NIOSH Heat Safety Tool App's success (ie, number of downloads) is a prime example of how an app on heat is highly desirable in workplaces. Half of the respondents were interested in additional printed materials, likely because these are easy to distribute during training and can serve as a reminder for some of the most important heat stress information (eg, HRI symptoms, first aid).

Several demographic variables were examined to determine whether training and educational needs and desires differed based on such variables. However, no significant differences were found. Although years of experience, company size, safety and health professional status, education, and climate region seemed to make no difference in this study, larger scale studies are needed to determine whether similar results are revealed.

Opportunities for public health educators

Public health educators play an important role in the planning, implementing, and evaluating of health programs as well as the dissemination of health promotion information. However, within the field of occupational safety and health (OSH), the role of health educators may be underused or nonexistent in some cases (eg, small businesses). There are ample opportunities for health educators working at health departments and elsewhere to provide assistance to their community workplaces. Sinclair et al²² used the diffusion of innovations and social exchange theory to identify steps specific to building relationships with small businesses which resulted in a model highlighting the important role of intermediaries, how they can deliver OSH information, and engage small businesses. Intermediaries may include trade associations, chambers of commerce, health departments, health providers, training organizations, and government agencies.²² Health educators

can act as intermediaries and assist in delivering heat training to these small businesses, addressing their specific educational needs and desires.

Limitations

This pilot study contained the following limitations. First, the small sample size may limit the generalizability of the overall findings. Follow-up studies that are larger in scale are needed. Second, some respondents may have answered in a socially desirable manner. Third, as this study employed an online survey, the potential for limitations in recall exists. Future studies are needed that specifically recruit workers with different backgrounds and potential vulnerabilities to determine whether heat stress training and educational needs differ.

Conclusions

This study provided insights into the heat-related training and educational needs of oil spill cleanup responders. The findings from this pilot study indicated that more training on acclimatization and implementing an acclimatization plan is needed. As responders continue to experience symptoms of HRI, there are likely ways to strengthen current heat stress prevention plans and further opportunities to increase their ability to cool down and avoid HRIs. Although current trainings, such as the commonly held just-in-time trainings, can likely be modified and improved to include items like acclimatization, it is also important to address the desires of a changing workforce to meet new needs related to faster, at-hand options.

Despite an abundance of available research-based knowledge, heat-related deaths and illnesses continue in workplaces. By understanding the needs of particular occupational populations, safety and health professionals, employers, and educators can create more effective guidance for implementation into workplaces and experience improved success at properly educating and training workers. There are opportunities for health educators to collaborate with organizations to focus on OSH research, specifically to assess gaps in heat stress training in various industries and small businesses. The dangers of environmental heat combined with the metabolic heat of the person working, such as during an oil spill cleanup effort, can result in illness, injury, and death. Appropriate training and education will provide for a safer work environment and more effectively protect workers.

The findings from this study may be beneficial to safety and health professionals and health educators, particularly those interested in developing heat stress training and educational materials for oil spill cleanup responders. As these companies become more digitalized, providing online training and educational applications will be a growing area of opportunity for safety and health professionals and health educators. Future studies should further examine workers, particularly those with limited educational backgrounds, and additional vulnerabilities, who may have specific needs related to training and education.

Author Contributions

BLJ designed the study, oversaw data collection, conducted data analysis, and led the interpretation and drafting and revisions of the manuscript. KAK guided the study design, data collection, and data analysis and participated in the interpretation of findings, comments on the manuscript, and its revisions. RAV and ALM guided the study design and interpretation and commented on the manuscript and its revisions. All authors read and agree with manuscript results and conclusions and approved the final manuscript.

ORCID iD

Brenda L Jacklitsch  <https://orcid.org/0000-0001-9529-6470>

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