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Chapter 2

Preventive Measures of Heat Disorder in the Workplace

Ivan Uher, Iveta Cimboláková and David Kaško

Additional information is available at the end of the chapter

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Abstract

Human adaptation to varying degree of heat stress receiving great attention in the last few decades. Scientific studies confirm that higher temperature can significantly impact on productivity and leads to stress, loss of concentration, and increased tiredness and that reality can become a health and safety issue especially for unwell and older workers in the workplace. The aim of our systematic review is to examine related ailments of heat exposure, when and why heat disorder (HD) occurs, also preventive measures, and first aid and emergency measures when HD is suspected. Nonetheless, guidance for management of working environment is discussed. We can conclude that organizations can do a great deal to be indwelt, creating a healthy workplace environment and promoting education and guidance toward welfare of employees.

Keywords: working environment, older people, health, safety, heat exposure

1. Introduction

Although the central Europe has a generally mild climate, there have been occasions when the weather has been particularly hot, especially in the midsummer when temperature exceeds 30°C in many parts of Europe. Exposure to heat is one of the physical hazards that can cause health problems in the workplace, heat is one of the most important and common occupational health problem in workplace. Inappropriate thermal conditions can impact the health and productivity of workers. However, successful control of occupational heat stress begins with the early identification of high-risk workers, but this task is not straightforward. Climate changes directly increases occupational heat stress for workers, which impacts their health and productivity. Heat stress is a physical hazard and potential health risk that can lead to a range of conditions [1].

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In our contribution we have opportunity to access already synthesized evidence and inform its practice. Our overview attempts to survey the literature in selected domain and describe its characteristics. Presented analysis is conceptual and thematic; synthesis is narrative and includes comprehensive searching. The aim of the study is to review related ailments of heat exposure, when and why heat disorder (HD) occurs, also preventive measures, and first aid and emergency measures when HD is suspected. Nonetheless, guidance for management of working environment is discussed.

When the workplace environment gets too hot, comfort is more than an issue about convenience. But also, if the temperature goes too high, it can become a health and safety issue especially for unwell and older workers in the workplace [2]. It is usually accepted that people work best at a temperature between 16 and 24°C [3], although this can vary depending on the kind of work being done and the gender. Despite of all that, strenuous work is better performed at a slightly lower temperature than office work. The HSE [4] recommends the following temperatures for different working areas (heavy work in factories, 13°C; light work in factories, 16°C; hospital wards and shops, 18°C; offices and dining rooms, 20°C). However, the law does not state a minimum or maximum temperature, but the temperature in workrooms should normally be at least 16 or 13°C if much of the work involves rigorous physical effort.

Scientific studies confirm that higher temperature can significantly impact on productivity and leads to stress, loss of concentration, and increased tiredness, which means there is an increase in the likelihood to put workers or coworkers at risk [5]. Heat can also aggravate other medical conditions and illnesses as well as interact with or increasing the effect of other workplace hazards. Heat disorders have been in the news more frequently in recent years due to climate changes caused by global warming [6]. Heat disorders can occur not only when our body is exposed to direct sunlight in the summer, when someone is working strenuously in direct sunlight in the summer, but also at the beginning of the summer, when people's bodies have not yet adjusted to the heat. HD can occur in hot, humid indoor environment as well. When the symptoms are severe, HD can be life-threatening but can be prevented if we are aware of precautionary measures. Prolonged or intense exposure to hot temperature can cause heat-related illnesses such as *heat syncope* where blood pressure decreases due to the dilation of the blood vessels in the skin, resulting in decreased flow of the blood to the brain. The person's pulse becomes quicker and weakens. Its manifestation includes dizziness, fainting, facial pallor, and quickening and weakening of the pulse [7]. On the other hand, *heat cramps* characterize cramps that are accompanied by pain in the legs, arms, and abdomen; symptoms occur when the concentration of salt (sodium) in the blood decreases due to heavy sweating, with fluid replaced by water only. Its manifestation can include muscle pain usually in the abdomen, arms, or legs, spasm, and muscle convulsion [7]. In *heat exhaustion*, a person is sweating profusely; if rehydration is inadequate, the person will become dehydrated and exhibit symptoms of heat exhaustion. Its symptoms include general feeling of malaise, nausea-vomiting, headache, dizziness, thirst, irritability, fast heartbeat, decreased ability to concentrate or make decisions, as well as cool, moist skin and heavy sweating [7]. *Heat stroke* is a condition where core bodily functions are impaired due to an excessively high body temperature [8]. Heat stroke may result in impairment of consciousness (slow reactions, unusual speech and behavior, loss of consciousness), where the body is going into a state of shock. Its manifestation includes high body temperature, disturbance of consciousness, slow reaction to calls and stimuli, unusual

speech and behavior, wobbly, also excessive sweating, or red, hot, dry skin. Not the last, *heat edema*, swelling in the legs and hands, can occur when we sit or stand for a prolonged time in a hot environment. Ultimately, we mention *heat rash*, also known as prickly heat, that is referring to skin irritation caused by sweat that does not evaporate from the skin. Heat rash is considered the most common problem in hot work environment. Its display includes clusters of red bumps on the skin, often appearing on the neck, upper chest, and folds of the skin [9].

2. Why heat disorders occur

Our body maintains a balance between heat production and heat loss; HD can occur when this balance is disrupted (body cannot transfer heat effectively or external heat gain is excessive). Our body produces heat constantly (thermogenesis) by allowing heat to escape from the body (heat loss). The human body maintains an internal temperature within a very narrow range. A normal temperature is 37°C but can fluctuate in a healthy person by about 0.6°C over the course of a day [10, 11]. This physiological adaptation can be a result of varying activity levels, and in women they can result from regular hormonal changes. Moreover, during work lots of heat is produced by the muscles, and as a consequence body temperature may rise. In fact, during times of heavy exertion, additional energy is expended, and nearly 75% of that energy is directed to heat rather than energy [12, 13]. At the same time, when it is hot outside, direct sunlight or reflected heat can result in a rise in body temperature even when the body is not active. When body temperature rises, blood flow at the body's surface (under the skin) increases, to make it easier for heat to escape from the body. When this happens, not enough blood flows to the brain, resulting in a lack of oxygen reaching the brain, which may cause dizziness or lightheadedness perhaps loss of consciousness. Sweating is another way the body allows heat to escape when body temperature rises considerably. If the water that is lost through sweating is not replaced adequately, this can result in dehydration; dehydration symptoms can include generalized malaise and nausea or vomiting; headache may occur. Sweat is product of the blood plasma. When sweat evaporates, heat is efficiently lost outside the body, lowering body temperature. Sweat contains electrolytes (ions), and sweating therefore results not only in the loss of water but also electrolytes. The electrolyte that is most easily lost in sweat is sodium, which is the most common electrolyte in blood plasma. And therefore, when we drink only water when we are sweating and does not replenishing it, the loss of salt may result in an inadequate salt balance in the body. Because salt plays a role in regulating muscle activity, insufficiency of salt can result in muscle spasms and cramping. If this condition persists, the body's mechanisms for regulating body temperature cannot keep up; body temperature can rise, and as a result, the brain is affected; the person may collapse and lose consciousness, which is extremely dangerous [14].

3. Occurrence of heat disorder and its potential risks for some groups of people

As we have already mentioned, higher than normal temperatures began in May, and by the end of August, the average temperatures are about 30% higher than normal for the season [15, 16].

Emergency hospitalizations due to a heatstroke occurs mostly in midsummer days when the temperature is above 30°C and can increase rapidly on very hot days to above 35°C [17].

In that context, when the temperature remains high night after night, a person's body temperature remains high even at night; this reality can initiate some health problems. Also, when the body is exposed to sudden high temperature, at these times, the body has not yet become adjusted to the heat and cannot sweat adequately and is therefore not capable of effectively regulating body temperature. Hence, when it is hot for a number of days in a row, the body can accommodate that heat by the process of heat acclimation. However, caution is needed when the conditions such as a high temperature, high humidity, no wind, direct sunshine, high temperatures brought on by reflected heat of the sun, or nearby heat sources are present that are typical for workplace environment. Although everyone needs to be careful about HD, there are some age groups that are particularly in danger to become subject of HD.

Older workers (40–65 years of age) are generally less able to cope with heat. In older adults, heart function becomes less efficient, and sweating starts later and occurs at a slower rate [18]. Statistics showing [19] that a higher percentage of males aged from 15 to 69 dies from HD than females. Men have a higher muscle mass and generally experience higher delivery while doing more strenuous physical work [20].

Within working people that possess higher risk for suffering from HD as we noted, we can include older workers. A general decline in bodily functions puts the older cohorts at particular risk for HD. As people age, their level of body fat tends to increase, and the proportion of their body that is water (their body water content) tends to decrease. Therefore, if older person is placed in the same environment as a non-older person, older person will be more susceptible to develop HD. The older is also less likely to notice the heat or become thirsty and are therefore less likely to drink enough liquid. In addition, because the older has decreased heart and or liver function, if they develop HD, their symptoms are more likely to become more severe. In comparison, body water content in child is 70–75%, adult male 60%, and older person 50–55% [20].

Recommended preventative measures for older cohorts include rehydration even when not thirsty, checking the location temperature frequently, and exercise enough to work up a sweat once a day. The older are at particular risk of heat disorders because of the factors such as older cohorts are less likely to feel the heat and the thirst. More likely they do not have enough fluid in the body [21]. Temperature control system tends to be delayed, and heat is likely to be trapped inside the body [13]. Also, when older cohorts eat less, the amount of take-in water decreases in line with the decrease in meal volumes; they have tendency to keep liquid intake low as to avoid having to go to the toilet so often. However, it is important for the older person to pay attention to his/her physical condition and get an adequate amount of water and salt (sodium) intake. The tips for preventing heat disorders in the older workers include rehydrating frequently and cooling the body with a shower and damp towels. Ensure good indoor airflow. Use air conditioning and fans effectively, and at the same time monitor the indoor temperature. Wear cool clothing. Know who to contact in case of emergency.

Further, to the group of people that are at higher risk for developing HD, we can include overweight or obese and people with low physical strength and endurance, i.e., people with

low fitness level and people who are not acclimatized to the heat. Seven out of ten heat-related deaths that occur in workplace are found in obese individuals [22, 23]. When there is more subcutaneous fat, heat does not escape from the body easily, and more heat is produced in moving a heavier body frame. Also, people who are low in fitness, are not accustomed to exercise, do hard work, and are not familiar with the conditions of their own bodies are more likely to overestimate their own potential. Temperature regulation systems of people who are in poor acute physical condition because of a lack of sleep, fatigue or are dehydrated as a result of drinking alcohol night before, these people are also at higher risk of developing HD. Here we can likewise include people with preexisting diseases and people who have previously had heat stroke. At that, people being treated for diabetes, hypertension, heart disease, kidney failure, psychiatric disorders, or extensive skin disorders are known to be more likely to develop HD [24].

4. Rehydration and food intake in hot environment

In general, a person loses approximately 2.5 l of water per day (approximately 1.5 l in urine, 900 ml through perspiration, and 100 ml in stools) [12, 13]. During the summer, we need to remain aware of the need to replenish the water lost through sweating. We need to be aware of the fact that when a person drinks a lot of water at once in order to replenish water that has been lost, this disrupts the electrolyte balance in the body that may result in a suboptimal physiological balance. As a rule, the amount of water intake should match the amount of water lost. Replenishing water lost alone is not enough. The salt lost through sweating also needs to be supplemented [10, 25].

The blood circulating in our body contains about 0.9% sodium, and some of this amount is lost when we sweat that is why our sweat tastes salty. If we sweat a lot (and thus lose sodium) and then drink only water, the concentration of sodium in our blood will become diluted, and we will stop wanting to drink water in order to prevent the sodium concentration from falling any further. We will also simultaneously eliminate excess water from the body as urine. This will result in not being able to replenish the volume of bodily fluid we had before we started sweating. Our ability to exercise will decrease; our body temperature will increase, and therefore we become more susceptible to develop heat disorders.

Rehydration technique includes intake of salt and sugar. When continue working in hot environment for an extended period of time, it is recommended to increase the sodium concentration in the body that will protect blood plasma to fall that may result to heat cramps.

Beverages containing carbohydrates are recommended because the sugar encourages fluid absorption in the gastrointestinal tract; that mechanism involves glucose which acts as a cotransporter with sodium in the intestinal tract; consequently water is absorbed due to the osmotic gradient produced by the coexistence of sugar and sodium. Marček et al. [13] recommend to include drinking beverages that contain sugar 0.1% to 0.2% and salt (40–80 mg sodium per 100 ml) for rehydration to prevent HD. Particularly when working for extended period of time, 1 h or longer in hot environment, beverages containing 4–8% sugar should be

drank. Although it is easier to drink chilled soft drinks or oral rehydration solutions, we can also make our own drink by dissolving half a teaspoon of table salt (2 g) and several sugar cubes in a 1 l of water.

Number of human studies [12, 26] have documented voluntary decreased of food intake in hot environment as an adaptive mechanism to ameliorate the increased need for thermoregulation. Optimal nutrition is compromised if intake decreases to the extent that inadequate levels of key nutrients are consumed. In that respect, we have to look on self-selected food pattern of individual engaged in similar activity in hot versus temperate climate as well as consider and determine the effect of stress on appetite, with temperature as a major variable. With such information available, we should be in position to develop basic recommendations for types of food that should be part of rations in hot environment, as well as determine if specific supplements with improved palatability be used when workers are in hot environment, where depressed appetite for prolonged periods of time may prevent adequate nutrient intake. A healthy diet is important when working in a hot environment; therefore we suggest meeting with a dietician familiar with high heat, high exertion environment such as workplace and to create a personalized plan that will lead to overall better acute and unexpired physical condition of employees.

5. Workplace environment acclimation and management

We can split up factors contributing to heat disorders in workplace into *environment factors* that encompasses temperature, humidity, direct sunlight, the presence or absence of wind, and onset of a heatwave in the working environment. *Individual factors* include particular differences in aerobic and anaerobic fitness level, general health condition, the person's physical health and level of fatigue, the degree to which the person is acclimated to the heat, clothing, acute and chronic mental state, etc. And *at work factors* embrace the plan for acclimatizing to the heat, regular rehydration and intake of salt, health checkup, and education. In that context when working in hot and humid work side, employer should set up a cool, air-conditioned rest area alongside the place, where you will have ice packs in coolers, thermoses of cold beverages (0.1–0.2% saline, electrolyte beverages, oral rehydration solutions, etc.), concurrent prepared salty snacks to enable periodic replacement of fluid and salt (sodium). It is advisable to have on the side cold damp towels and to take showers and other means that allow workers to cool themselves down.

Occurrence of HD is a consequence of inadaptability of the human body to cope with excessive heat. When the body is exposed to high intensity work, time is required for heat acclimatization. Plank et al. [25] claim that worker should spend 7 or more days gradually lengthening the time of exposure to heat.

From the physiological perspective, even if one is not thirsty, fluid and salt must be replaced periodically during work, as well as before and after work. Employees should have 0.1-0.2% saline, electrolyte beverages, and rehydration solutions prepared at convenient locations, such as work site and rest area. People with restricted salt intake should consult their doctor or company physician. Superiors are expected to check and provide thorough instructions regarding the replacement of fluid and salt.

Also, when working under direct sunlight, it is advisable to wear something that wards off the sun, such as a cap or a cool helmet. Bright colors that reflect radiant heat are recommended, and the use of cold packs can be effective. Workers should try to wear moisture permeable wearing apparel and clothing with good ventilation properties. When the pulse rate of the employee exceeds (220 minus the age of the person), or the body temperature does not return to the temperature before starting work during a break. Or else, body weight had decreased by more than 1.5% since the start of work. On the proviso symptoms such as acute fatigue, nausea, dizziness, or loss of consciousness are observed. If any of the abovementioned signs of heat stroke are discovered, the body must be rested and cooled immediately. In that context the work place should provide rest areas with medical thermometers and weight scales so that people's physical conditions can be checked if necessary immediately.

Further, the appropriate management action should be taken in response to the results of health checkups. When abnormalities are found during a general health checkup, opinion of a physician should be taken into consideration. Managers are required to take measures in such a case to change the worker's work site or work assignment or to lighten the workload [27]. The work site must be changed or the work switched, in reference to the opinions of a physician or other competent individuals, for people with a condition that could affect the development of HD (e.g., diabetes, high blood pressure, heart disease, kidney failure, neuropsychiatric disorders, and a wide range of other elements).

Simultaneously, managers should monitor daily physical aspects of their workers; conditions such as lack of sleep, hangovers, fever from a cold, and dehydration from diarrhea can increase the risk of HD. At such times, the condition should be reported in order to prevent HD. Moreover, managers and superiors should periodically check workers health condition and their intake of fluids before and during working hours. It is also effective and advisable to check on fellow workers for changes from their usual condition, since heat stroke at times occurs quite unexpectedly and abruptly [28].

Last but not least, managers and workers should learn about HD before it starts to get hot following the winter season. They should be informed about signs and symptoms of HD, to know preventive measures, also to know how to manage HD first aid for emergencies, and last but not least to become familiar with the case studies of HD from the past.

6. First aid and emergency measure when heat disorder is suspected

Concurrently, superior should prepare an emergency contact network and ensure workers are aware of it. Relevant people should be made aware of emergency manuals and the phone numbers and locations of hospitals and clinics. If someone develops the symptoms of heat disorders at a hot and humid work site, it is important at first to move the person to a cool location, remove his/her clothing, and cool the body. If the person cannot drink fluid on his/her own, take the person to a medical facility immediately, even if the person remains conscious. There are various signs and symptoms to look out for that may indicate a heat disorder. We should take appropriate countermeasures immediately if we notice initial symptoms such as dizziness

or lightheadedness. As heat disorders can be life-threatening, it is important to be aware of what to look out for and to follow the appropriate first aid procedures if a heat disorder is suspected. If one of the following conditions is observed, we should get medical attention immediately. And that includes dizziness, loss of consciousness, muscle pain, rigidity, profuse perspiration, headache, malaise, nausea, vomiting, fatigue, despondency, impairment of consciousness, convulsions, impaired motor functions, and elevated temperature. If the person is unconscious or shows impaired consciousness, it is important to call an ambulance immediately. Emergency measures must be taken to cool the person while waiting for the ambulance to arrive [29].

Immediate on-site emergency measures should be implemented, whether an ambulance is called or not. If a heat disorder is suspected, the person should be moved to a cool place, cooled, and rehydrated with fluids and electrolytes, regardless of the severity of symptoms. Fluid should only be given if the person is capable of consuming them on his own. We should move the person to a shaded place with good air circulation or to an air-conditioned place.

Follow by removal of or loosening up tight clothing to let heat escape, dampen the exposed skin with cold water, and use a paper or electric fan to cool the body. If ice packs are available, we may use them to cool areas with large blood vessels near the surface of the skin, such as the neck, under the arms, and the groin area. If the person is conscious, have him consume a cold beverage containing an appropriate number of electrolytes. A sports drink (containing 40–80 mg of salt per 100 ml) or oral rehydration solution that can replenish electrolytes lost through perspiration is recommended. If the person does not respond to stimuli or shows signs of impaired consciousness, do not force him to drink, as fluid could enter the respiratory tract. If the person is nauseous or vomiting, fluids should be given intravenously at a medical facility [30].

However, the person must be taken to a medical facility if their body temperature is high, if he/she is unable to consume fluids or electrolytes (saline solution) on their own, or if symptoms worsen or fail to improve. Even in the absence of clear symptoms, we should call an ambulance, immediately if the person shows slowed reactions and impaired speech or movement. Last but not least, if heat exhaustion or heat stroke is suspected, examination at a medical facility is recommended as the person's condition may change suddenly even after symptoms improve.

7. Guidance about management of HD in working environment

Management in working environment should establish at each work side some risk factors indicators to evaluate the risk of HD. The risk indicator factors are device that indicates heat stress levels by measuring temperature, humidity, wind, and radiant heat. That can be used as a measure for evaluation of the risk for HD. Management should create additional air-conditioned rest areas if necessary, considering the number of workers engaged in the emergency work and the distance they transfer to that place.

Management responsibility includes to work sensibly and pace work schedules by establishing maximum working hours and avoiding heat by working in the early morning or in the

evening when the temperature is relatively cool. Workers should be advised to avoid any severe work conditions. For example, do not work during the higher temperature period from 2 to 5 PM in the months of July and August, when fatal accidents due to heat disease have been frequently observed among workers [31]. Time should be given to workers to become adjusted to the high-temperature work environment while they determine their best pace of work and frequencies of rest. Work managers and superiors should raise awareness among their workers about water and salt intake and make sure that the workers are provided with sufficient supply of water and salt regardless of their conditions. In addition, work managers should evaluate the physical conditions of each worker with a check sheet. Ensure workers wear functional clothing that keeps their body temperature cool. Appoint person who will be responsible for monitoring workplace, inspecting working conditions and ensure that the above-mentioned measures are thoroughly implemented.

It is strongly recommended that work superior confirms physical conditions of each worker before work. More specifically sleeping hours, whether they had breakfast, whether alcohol intake on the previous day, and whether they are suffering from fever or diarrhea or any other health issues should be evaluated with a check sheet or other appropriate means.

Work managers should be aware of any underlying chronic disorders or issues of workers such as, diabetes, hypertensions, cardiac disease, kidney failure, and so forth, which could potentially heighten risks for HD. Further, implement appropriate measures such as setting maximum working hours for these special needs workers.

From the educational point of view, company should provide training and inform its workers about the symptoms of the HD, methods for heat disorders prevention, and emergency measures for protecting employees from radiation, in addition to providing education for work management and superior. Furthermore, critical information about emergency measures should be disseminated to every worker by posting flyers at designated area.

8. Technics and norms for evaluating hot environment working conditions

Between acceptable measures and methods of heat stress assessment technic, we can include measurement of environmental parameters and direct measurement of body temperature and also the measurement of other physiological responses, such as heart rate. The most common and widely used throughout the world environmental measurement tool is the heat stress index more specifically the “Wet bulb globe temperature” (WBGT). It was developed in a US Navy investigation into heat casualties during training [32] as an approximation to the more cumbersome corrected effective temperature (CET), modified to account for the solar absorptivity of green military clothing. The WBGT combine the effect of humidity and air velocity (natural wet bulb), ambient air temperature, velocity, and radiant energy (global temperature), as well as air temperature (dry bulb temperature) that is framed into a single value. On the other hand, direct measurement of body temperature includes measurement of the core body temperature and heart rate. Core body temperature can be measured either direct

using oral or tympanic (eardrum/canal) temperature. Oral temperatures are determined by measuring temperature at the base of the tongue. The worker must not drink or eat anything cold or hot for at least 15 min before measurement. The thermometer must be inserted under the tongue, as far as possible, for about 5 min, and the mouth must be kept closed as much as possible. Oral temperature is approximately 0.4°C lower than rectal temperature [25].

Also, the recovery heat rate during rest periods following a work cycle in a hot environment is a measure that can be used to monitor heat stress. There are two models for recovery of heat rate. The first [33] recommends a heart rate criterion level of 110 beats per minute during the first minute of a rest period after work in a hot environment, followed by a reduction in heart rate of 10 beats per minute by the end of the third minute of rest. Levels above these values are indicative of exposure to a heat stress environment. The second model [34] recommends that the heart rate in the third minute of a rest period after work in a hot environment should not exceed 90 beats per minute. In that context, mean skin temperature, internal body temperature, heat rate, and mass loss will be of interest that will provide guidance for medical supervisor. An overall assessment predicts if unacclimatized workers is suitable for work that could be carried out in an 8-h shift without undergoing unacceptable (thermal) physiological strain.

Despite of all that in fact, there is no single comprehensive and specific standard that covers working in hot environments. However, we have available for use "heat index" for people working outdoor in hot weather. The heat index is a single value that takes both temperature and humidity into account. The higher the heat index, the hotter the weather feels, since sweat does not readily evaporate and cool the skin. The heat index is a better measure than air temperature alone for estimating the risk to workers from environmental heat sources.

Table 1 can emerge as a guide that helps employers and worksite supervisors to prepare and implement hot weather plans to determine when extra precautions are needed to protect workers from environmental contributions to heat-related illness [45]. Nevertheless, workers performing strenuous activity, workers using heavy or non-breathable protective clothing, and workers who are new to an outdoor job need additional precautions beyond those warranted by heat index alone. Moreover, the index values were devised for shady, light wind conditions, and exposure to full sunshine can increase heat index values by up to 15°F, 9°C. To account for solar load, added precaution is recommended. Nonetheless, heat stress is not only an outdoor health hazard. Employees working indoors in elevated temperature can also demonstrate symptoms of heat-related illness especially in the factories where similarly valid

Heat index	Risk level	Protective measures
Less than 91°F, 33°C	Lower (caution)	Basic heat safety and planning
91°F,33°C, to 103°F, 39°C	Moderate	Implement precautions and heighten awareness
103°F, 39°C, to 115°F, 46°C	High	Additional precautions to protect workers
Greater than 115°F, 46°C	Very high to extreme	Triggers even more aggressive protective measures

http://osha.gov/SLTC/heatillness/heat_index/

Table 1. Criteria for heat stress exposure.

measures should be taken. By contrary, in the office environment temperature and humidity are a matter of human comfort. There are no regulations specifically addressing temperature and humidity in an office setting. However, American Occupational Safety and Health Administration [35] recommends temperature control in the range of 68°–76°F/20–24°C and humidity control in the range of 20–60%. This standard discusses thermal comfort within the context of air temperature, humidity, and air movement and provides recommended ranges for temperature and humidity that are intended to satisfy for the majority of building occupants. We must also not forget that in 2003 the heatwave across Europe reportedly claimed 35,000 lives [36], and as a result, Public Health England (PHE) introduced the Heat-Health Watch system that operates in England from June 1 to September 15 each year, in association with Public Health England. It is based solely on temperature factors, and their potential health impactions cover whole of England. That leads to warnings being made if a daytime temperature in excess of 30°C, or nighttime temperature in excess of 15°C is expected, This, enables organizations, frontline staff, and individuals to take action to minimize the impact of the heat on people's health. This also can be seen as one of the monitoring techniques as a preventive measure for heat-related issues.

9. Discussion

As we have mentioned, the increase in global temperatures and relative humidity has a direct effect on the human body, thus increasing the incidence of heat stress. Workers more vulnerable to these effects include those with long-term conditions, particularly those with comorbidities, and these are more likely to affect the older rather than the younger workers. In that reality, it is easier to look for ways to prevent HD conditions rather than having to treat them. From our perspective, appropriate monitoring criteria and working control mechanism should be in place on the each working site, embracing general as well as specific criteria, depending on the workplace circumstances where some professional judgment is required. The individual performing the monitoring should be knowledgeable of the monitoring methods and know which criteria to use in determining whether a worker is suffering from a HD or else is ready to return to work under hot conditions. In that reality it is important to create continuous effort to study monitoring methods that from our view plays an important role in assessing employee ability to maintain work under certain conditions.

Furthermore, there is a need to train workers not only in times of heat waves but also before hot work day begins, outlining employer-specific policies and worksite-specific conditions. We have to take into consideration that a single worksite may have some job tasks that are low risk for HD and others that are at high risk [46]. Therefore, training will be more effective if it is matched to job tasks and conditions and is reviewed and reinforced throughout hot weather conditions. Also, workers should be aware of the heat index for the day and identify all of the precautions.

The training for employees should be designed to be short, participatory, and easy to follow [44]. It is necessary to emphasize lifestyle of employee and its domains (physical condition, nutritional status, and mental state) that can to a great extent influence an overall health of the employee. To make employee to understand, why it is important to prevent heat illness,

that includes health effects of heat, how to respond to symptoms and how to prevent heat exhaustion. Over and above, the occupational and environmental health nurses and their role as front runners have to be stressed. Supervisors should know their duties that include recognition and treatment of the broad range of symptoms that can result from exposure to high temperatures. They must work together with interdisciplinary teams to provide education and training for the workforce so that workers will be able to take appropriate measures to prevent the onset of a heat-related illness, recognize the early symptoms, and seek adequate treatment. Interdisciplinary teams must ensure that competent controls in the work environment reduce the risk of heat exposure and related heat stress disorders. From our perspective, proper education and early intervention are the key to avoid heat-induced illnesses in order to eliminate or minimize the effects of high-temperature environmental conditions.

Looking into the past, Occupational Safety and Health Administration (OSHA) of the United States enforces heat illness cases and declares heat-related illness to be the most common cause for work-related hospital attendances among workers [37, 43]. This is mainly among construction and outside workers. It was also reported that two-thirds of the fatalities that occurred between 2012 and 2013 happened between the first and third days of work [38]. That reality can help us to emphasize priorities in preparation for dealing with such complex issues. Potential difficulties may arise also in countries, where extreme heat is infrequently experienced and workplaces have limited practice skills of dealing with such issues. Occupational health and safety professionals in those countries should be well advised and trained to consider how working in elevated summer temperatures is best managed. In that context, countries with extended knowledge, skills, and experience should be supportive in their expertise, providing manpower (experts) solely but for most part communicate and share knowledge in advance.

10. Conclusion

In conclusion, health effects from increased temperatures can have both positive and negative effects. An increased sense of well-being and positive energy can be experienced when temperatures start to increase and the sun starts to come out after the prolonged cold and darker winter. Contrary, health symptoms such as fatigue, irritability, and inability to concentrate along with all the other negative health effects related to heat stress provide a negative experience.

Nearly a third of the world's population in now exposed to climatic conditions that produce deadly heatwaves. Global warming and other environmental changes are driving the likelihood of extreme heat events higher at a time when we are seeing continued urbanization, industrialization, and an aging population. The nexus between these environmental and social factors places us on a certain path toward severe and lethal heat waves in the future, with nearly half of the world's population set to suffer periods of deadly heat by the end of the century even if greenhouse gases are radically cut [39, 40]. Study of Mazdiyasni et al. [41] shows that risks have climbed steadily since 1980 and the number of people in danger will grow to 48% by 2100 even if emissions are drastically reduced.

Therefore, it is important to understand and create effective measures to prepare, to predict, and to manage heat waves that we may experience in the future. In the future, more cross-sectional, longitudinal studies are needed in order to shed light to understand mechanism and factors that influence connection between heat exposure on the human body as well as its environmental, social, and economic impact on the individual and the society.

Organizations can do a great deal to assist, by creating a healthy workplace environment and promoting education not only for superior and health workers but also for employees. Enhance workers' comfort as a way of reducing turnover and increasing retention of employees [42]. At the same time, support older workers to remain in the workforce with lower risk. This will in turn have benefits for the recruitment and retention of the workers, especially in times of rapid aging of the European population.

Also, professionals in the field should develop cybernetic-based computer program that will embrace a multitude of environmental and personal variables that can predict potential risk for development of health disorder.

At the very end, we should emphasize that only healthy worker (health with age has tendency to deteriorate) can successfully deal with such threat condition as heat exposure no doubt represents. We believe that modification of individual lifestyle (their domains) places crucial role, and this is no doubt individual responsibility. In that context employee should stretch further to educate, motivate, and create condition for its employees to be healthy that on the end will benefit not only individual and his close and distance environment but also society as a whole. On the very end, we can conclude that only healthy men can create safe, prosperous, and well-performing working environment, and that is the goal.

Author details

Ivan Uher[1]*, Iveta Cimboláková[1] and David Kaško[2]

*Address all correspondence to: ivan.uher57@gmail.com

1 Department of Physical Education and Sport, University P.J. Šafarika Kosice, Košice, Slovakia

2 Faculty of Sports, University of Prešov, Prešov, Slovakia

References

[1] McIver L, Kim R, Woodwards A, et al. Health impacts of climate change in Pacific Island countries: A regional assessment of vulnerabilities and adaptation priorities. Environmental Health Perspectives. 2016;**124**(11):1707-1714. DOI: 10.1289/ehp.1509756

[2] Kaiser M. How the Weather Affects Your Health. Michelle Anderson. USA: Pty. Ltd; 2009. p. 376. ISBN 10:1427096357

[3] Nguyen JN, Schwartz J, Dockery WD. The relationship between indoor and outdoor temperature, apparent temperature, relative humidity, and absolute humidity. Indoor Air. 2014;**24**(1):103-112. DOI: 10.1111/ina.12052

[4] Health and Safety Executive. Temperature in the Workplace—Frequently Asked Questions. 2018. http://www.hse.gov.uk/temperature/faq.htm

[5] Crimmins A, Balbus J, Gamble JL, et al. The impact of climate change on human health in the United States: A scientific assessment. Report. Washington, DC: U.S. Global Research Program; 2016. DOI: 10.7930/J0R49NQX

[6] Canadian Institute of Actuaries. Climate change and resource sustainability an overview for actuaries. Research Paper; 2015. p. 56. https://www.cia-ica.ca/docs/default-source/2015/215068e.pdf

[7] Goldman L, Schafer AI. Goldman-Cecil Medicine. 25th ed. Vol. 22015. p. 3024. ISBN: 978-1-4557-5017-7

[8] Bouchama A, Knochel JP. Heat stroke. The New England Journal of Medicine. 2002; **346**:1978-1988

[9] Levin N. Signs of Heat Rash. 2016. https://www.onhealth.com/content/1/heat_rash

[10] Javorka K et al. Lekárska Fyziológia. Učebnica pre Lekárske Fakulty. 2nd ed. Slovak republic: Osveta; 2006. pp. 337-351. ISBN 80-8063-231-6

[11] Wikipedia. Human Body Temperature. 2018. https://en.wikipedia.org/wiki/

[12] Langmeier M et al. Základy Lékařské Fyziologie. Czech republic: Grada; 2009. p. 299. ISBN 978-80-247-2526-0

[13] Marček T et al. Telovýchovné Lekárstvo. University Komenského Bratislava; 2007. p. 255. ISBN 978-80-223-2276-8

[14] Hall E. Guyton and Hall Textbook of Medical Physiology. 13th ed. USA: Elsevier; 2015. p. 1168. ISBN-10:1455770051

[15] Canadian Centre for Occupational Health & Safety. Hot Environments: Health Effects. 2001. www.ccohs.ca/oshanswers/phys_agents/heat_health.html [Retrieved: March 17, 2018]

[16] Clements BW. Disasters and Public Health. Planning and Response. Amy Pedersen; 2009. pp. 171-190. ISBN 978-1-85617-612-5

[17] Yamamoto T, Todani M, Oda Y, Kaneko T, Kaneda K, Fujita M, Miyauchi T, Tsuruta R. Predictive factors for hospitalizations of patients with heat illness in Yamaguchi, Japan. International Journal of Environmental Research and Public Health. 2015;**12**(9): 11770-11780

[18] Work Safe BC. Working to Make a Difference. Preventing Heat Stress at Work. Canada: Workers' Compensation Board of British Columbia; 2007. p. 22. ISSN 1715-2747. http://www.occupationalhealthandsafetylaw.com/preventing-heat-stress-in-the-workplace

[19] Perčič S, Kukec A, Cegnar T, Hojs A. Number of heat wave deaths by diagnosis, sex, age groups, and area, in Slovenia, 2015 vs. 2003. International Journal of Environmental Research and Public Health. 2018;**15**:173

[20] Seliger V, Vinařický R, Trefný Z. Fysiologie Tělesných Cvičení. Avicenum. Czech republic: zdravotnícke nakladatelství Praha; 1980. p. 333

[21] Spirduso W, Francis K, MacRae P. Physical Dimensions of Aging. 2nd ed. USA: Human Kinetics; 2005. p. 384. ISBN-13: 9780736033152

[22] U.S. Centers for Disease Control and Prevention (CDC). Compressed Mortality File, Underlying Cause of Death. 2016. http:/wonder.cdc.gov/mortSOL.html [Accessed: February, 2016]

[23] Kenny GP, Yardley J, Sigal C, Jay RJO. Heat stress individuals and patients with common chronic diseases. Canadian Medical Association Journal. 2010;**182**:1053-1060

[24] Lopez MR. Quick Questions Heat-Related Illness. USA: Slack Inc.; 2015. p. 226. ISBN 1617116475

[25] Plank L, Hanáček J, et al. Patologická anatómia a patologická fyziológia. Slovak republic: Osveta; 2007. p. 284. ISBN 978-80-8063-241-0

[26] Marriott MB. Nutritional Needs in Hot Environments. USA: National Academy Press; 1993. p. 392. http://www.nap.edu/catalog/2094.html

[27] Eisenberg J, Methner M. Health hazard evaluation program. NIOSH. Report No. 2013-0109-3214; 2013. p. 35. http://www.cdc.gov/niosh/hhe/reports/pdfs/2013-0109-3214. pdf

[28] Jacklitsch B, Williams WJ, et al. Occupational exposure to heat and hot environments. NIOSH. 2016;**106**:157. www.cdc.gov/niosh Revised Criteria 2016

[29] McNab CH. First Aid Survival Guide. USA: Amber Books; 2017. pp. 112-140. ISBN 978-1-78274-538-9

[30] Abderrezak B, Dehbi M, Chaves-Carballo E. Cooling and hemodynamic management in heatstroke: Practical recommendations. Critical Care. 2007;**11**(3):R54. DOI: 10.1186/cc5910. https://ccforum.biomedcentral.com

[31] Rocklov J, Barnett AG, Woodward A. On the estimation of heat-intensity and heat duration effects in time series of temperature-related mortality in Stockholm, Sweden. Environmental Health. 2012;**11**(1):237. DOI: 10.1186/1476-069X-11-23

[32] Yaglou CP, Minard D. Control of heat casualties at military training centers. A.M.A. Archives of Industrial Health. 1957;**16**:302-316 and 405

[33] Brouha L. Physiological aspects of work measurement. Occupational Health Review. 1964;**16**:3-7

[34] Fuller S. Occupational Ergonomics. Theory and Applications. USA: Marcel Dekker; 1996. pp. 195-219. ISBN 0-8247-9419-2

[35] Occupational Safety and Health Administration (OSHA). OSHA Policy on Indoor Air Quality: Office Temperature/Humidity and Environment Tobacco Smoke. Indoor Air

Quality Investigation, Recommendations for the Employer. Section III: Chapter 2. 2001. osha.gov

[36] Freser J. Research Health and Safety. Continuing Professional Development. Health and Safety Executive. 2017. https://www.personneltoday.com/hr/older-workers-and-heat-stress-challenges-of-working-in-a-hot-environment/

[37] Occupational Safe and Health Administration (OSHA). Safe Work in the 21st Century. US: National Academies Press; 2000. ISBN-10:0-309-07026-0

[38] Arbury S, Lindsley M, Hodgson M. A critical review of OSHA heat enforcement cases: Lessons learned. Journal of Occupational and Environmental Medicine. 2016;**58**(4): 359-363. DOI: 10.1097/JOM.0000000000000640

[39] Guo Y, Barnett AG, Pan X, Yu W, Tong S. The impact of temperature on mortality in Tianjin, China. Environmental Health Perspectives. 2011;**119**(12):1719-1725. PMID: 21827978. DOI: 10.1289/ehp.1103598

[40] Guo Y, Gasparrini A, Armstrong BG, Tawatsupa B, et al. Heat wave and mortality: A multicountry, multicommunity study. Environmental Health Perspective (EHP). 2017;**125**(8):1-11. DOI: 10:1289/EHP1026

[41] Mazdiyasni O, Kouchak AK, Davis SJ, Madadgar S, et al. Increasing probability of mortality during Indian heat waves. Science Advances. 2017;**3**(6):1-5. DOI: 10.1126/sciadv.1700066

[42] Lewis S. Adapting OH to strengthen an ageing workforce. Occupational Health & Wellbeing. 2015;**67**(3):22-23

[43] Employment Health and Safety, Daily Advisor. Injuries and Illness. 2018. http://ehsdailyadvisor.blr.com/2008/06/6-ways-to-prevent-heat-stress-at-work/

[44] Mather GW, Boris I, Kit V, Gail A, Bloch A, Herman MF. Man, His Job, and the Environment. A Review and Annotated Bibliography of Selected Recent Research of Human Performance. USA: United States Department of Commerce; 1970. p. 99. NBS Special Pub. 319

[45] Occupational Safety and Health Administration (OSHA). Using the Heat Index: A Guide for Employers. 2018. https://www.osha.gov/SLTC/heatillness/heat_index/

[46] Stellman MJ. Encyclopaedia of Occupational Health and Safety. 4th ed. Geneva: International Labour Office; 1998. ISBN 92-2-109203-8. https://www.thenbs.com/PublicationIndex/Publisher/Index?FirstLet-H