Management of Heat Stress at Workplace

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Abstract: The average global temperature is increasing and it is estimated that it will go up a further 1.8-4.0^{0}C (estimated average 3.0^{0}C) by 2100, depending on actions to limit greenhouse gas emissions. The extent of local climate change will vary depending on geographic and local meteorological conditions. Modern urban development can add several degrees to local temperatures through heat absorption in concrete buildings, road tar-seal, etc. Increasing local ambient temperature means higher human exposure to heat, which during hot seasons in hot parts of the world can create very unhealthy environments for people who are not able to protect themselves with air conditioning or other cooling methods. Many jobs require working in hot environments, both outdoors and indoors. Working in the heat and doing heavy physical work can affect the body's cooling system. If the body is unable to cool itself, a worker can experience heat stress. If heat stress is not recognized and treated in the early stages, more serious and even fatal conditions may quickly develop. The present paper aims at reviewing the mechanism of heat regulation in the human body, the causes of heat stress, its various stages and the preventive measures that can be taken by both the worker and the employer to prevent heat stress.
Keywords: Heat stress, Climate change, workplace, heat, productivity

1 Introduction

Global climate change will affect living and working environments, and create health threats for millions of people. The average global temperature is increasing and it is estimated that it will go up a further 1.8-4.0°C (estimated average 3.0°C) by 2100, depending on actions to limit greenhouse gas emissions. The extent of local climate change will vary depending on geographic and local meteorological conditions. Modern urban development can add several degrees to local temperatures through heat absorption in concrete buildings, road tar-seal, etc. Increasing local ambient temperature means higher human exposure to heat, which during hot seasons in hot parts of the world can create very unhealthy environments for people who are not able to protect themselves with air conditioning or other cooling methods. Both general living environments and working environments are affected. The latter may create impacts both on workers' health and on economic conditions. Workers in low and middle-income tropical countries are likely to be at highest risk of excessive heat exposure.

Many jobs require working in hot environments, both outdoors and indoors. Working in the heat and doing heavy physical work can affect the body's cooling system. If the body is unable to cool itself, a worker can experience heat stress. If heat stress is not recognized and treated in the early stages, more serious and even fatal conditions may quickly develop. Workers who are required to work in hot conditions must be adequately prepared to deal with heat stress. Outdoor work activity often increases during the hot summer months, particularly in construction, roofing, forestry, forest fire fighting, and road construction. Indoor work activities in hot environments expose workers to heat year-round. These include working in pulp and paper manufacturing, industrial laundries, bakeries, steel manufacturing and fabricating, boiler rooms, and working near cement kilns. Workers exposed to hot environments must be trained to prevent heat stress and to recognize the early symptoms of heat stress in themselves and co-workers.

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2 What is heat stress?

Human bodies naturally maintain temperatures between 36°C and 38°C. When the body temperature rises above this range, the body will react to get rid of the excess heat. However, if the body continues to gain heat faster than it can get rid of it, the body temperature increases and the person experiences heat stress.

3 Understanding how the body regulates heat

The temperature of the human body is not, as often assumed, uniform throughout. A constant temperature, which fluctuates a little around 37°C, is found only in the interior of the brain, heart and abdominal organs. This is the so called core-temperature. A constant core temperature is a prerequisite for the normal functioning of the most important vital functions and wide or prolonged deviations are incompatible with the life of a warm-blooded animal. In contrast, the temperatures in the muscles, limbs and above all in the skin show great variations. This is the so-called shell temperature. It varies according to the body's need to either conserve heat or to dissipate it.

The underlying rule is that energy always flows from the warmer to the colder. When the surrounding air is cool and if the body wants to prevent heat outflow, blood circulation to the skin is much reduced, making the skin look pale and lowering its temperature so there is little heat loss. If the body must lose heat, then the skin is well supplied with warm blood to have a steep temperature gradient to the outside. In warm surroundings the task is usually to dissipate heat; thus the skin will be kept as warm as possible by bringing 'hot' blood to just below its surface. This helps especially to evaporate sweat, the body's most important means to dissipate heat.

A portion of the heat that is given off as a by-product of biochemical reactions is used to maintain a nearly constant body core temperature. If that temperature starts to fall by a couple of degrees, mechanisms such as shivering are used to generate additional heat to help maintain the core temperature. The process of work generates more heat than is normally needed to maintain the core temperature. If we generate more excess heat than we can get rid of, our core temperature will start to rise and we have the stage set for heat stress.

4 Sources of heat

The body can gain heat in two ways: it can generate heat itself through work activity, and it can absorb heat from the environment. Both work activity and the environment are important sources of heat, and sometimes the work activity itself can be the main source of heat stress. Cases of heat stress have been reported when the air temperature was relatively low but the physical activity level of the work was very high.

4.1 Heat from activity

The amount of heat generated by the worker (internal heat) depends on the workload (the level of physical activity). Table 1 gives some examples of light, moderate, and heavy workload.

Table 1: Examples of light, moderate, and heavy workload

Workload	Activity	Examples
Light	Sitting with moderate movement of arms and legs Standing. Doing light work, with mostly arm movement Casual walking	Desk work; typing; driving in light traffic Assembly line work Supervising a worksite
Moderate	Brisk Walking Sitting, with vigorous arm and leg movement Standing, doing light to moderate work, including some walking Moderate lifting or pushing	Delivering mail Driving heavy machinery; industrial cleaning Picking fruit and vegetables Warehouse work; loading and unloading of trucks
Heavy	Construction tasks Intermittent heavy lifting, pushing, or pulling Climbing stairs with heavy gear	Sawing: planning; digging; shoveling; sledgehammer work; roofing Restocking shelves; asbestos removal Fire fighting

4.2 Heat from the environment

The amount of heat gained from the environment (external heat) depends on the surrounding air temperature, the amount of air movement, and any radiant heat. Some examples of radiant heat sources are heaters, boilers, fires, and sunlight. The addition of heat from radiant sources can cause overheating even when the air temperature is not high.

5 Removal of heat from the body

The body can usually get rid of excess heat, but how much heat is removed depends on several factors such as surrounding air temperatures, humidity, air flow, clothing, and personal risk factors. If one or more of these factors make it difficult for the body to get rid of excess heat, heat disorders may develop. The body has two main ways to get rid of excess heat: by increasing blood flow to the skin and by sweating.

6 Personal risk factors

Since people respond differently to heat, it is important to know the common risk factors that may increase the chance of a worker developing heat stress. These include:

- Lack of acclimatization. A person who regularly works in a hot environment will be at a lower risk of developing heat disorders than a person who does not.
- Poor physical fitness. Physically fit people are generally better able to cope with heat stress and less likely to develop heat disorders.
- Obesity. Excess fat provides increased insulation, which reduces heat loss. People with excess weight may also generate more heat during activity.
- Increased age. Older workers (40 to 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.

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• Pre-existing medical conditions or treatments. Some common medical conditions and treatments can decrease a person's ability to cope with heat stress. For example, heart problems and treatments such as low-salt (low-sodium) diets, diabetes mellitus, cystic fibrosis, and hyperthyroidism.
• Short-term disorders and minor illnesses. Feverish illnesses, diarrhoea, and vomiting can all cause excess loss of fluids, which may decrease a person's ability to cope with heat.
• Chronic skin disorders. Rashes, dermatitis, healed burns, and other skin conditions that involve large skin surface areas may limit the body's ability to sweat properly.
• Use of medication. Some medications that may cause problems when working in heat stress conditions include: Anticholinergic drugs, Antihistamines, Antipsychotic phenothiazines, Beta blockers, Calcium channel blockers, Cyclic antidepressants, Diuretics, Lithium, Monoamino oxidase inhibitors
• Alcohol and drugs. Alcohol intake increases water loss, and can cause even acclimatized workers to become dehydrated. Some street drugs increase internal body heat and decrease the ability to lose heat.
• Previous heat stroke. Workers who have previously suffered from heat stroke are at increased risk for recurrence.

7 Hazards of Heat Stress

A number of physiological problems are related to the build-up of excessive heat in the body. They range from annoying skin rashes to potentially fatal heat stroke.

7.1 Heat cramps

Heat cramps are painful muscle cramps caused by losing too much salt through sweating; they are usually the result of heavy exercise or physical work in a hot environment. The cramps typically occur late in a workday or after the muscles have cooled (for example, during a shower after work).Signs and symptoms-Muscular pain or spasms, Excessive sweating.

7.2 Heat exhaustion

Heat exhaustion is caused by depletion of both water and salt, due to sweating during prolonged periods of exertion, when fluid replacement has not been sufficient to match losses. It is more serious than heat cramps, and the worker will have a number of other signs and symptoms-shallow respiration, Increased respiratory rate, Weak rapid pulse, Cool, pale, clammy skin, Sweating, Weakness, fatigue, dizziness, Headache and nausea, Fainting, Muscle cramps.

7.3 Heat stroke

Heat stroke occurs when the body's mechanisms for heat dissipation are overwhelmed and fail. Heat stroke is a life-threatening condition in which the body's core temperature rises above 41°C. At core body temperatures over 41°C sweating stops and the body is unable to get rid of heat, causing body temperature to continue to rise. The person's mental functions may become disturbed. Signs and symptoms include, Hot, dry, flushed skin, Absence of sweating, Agitation, confusion, Decreased level of consciousness, Headache, Nausea and vomiting, Seizures, Increased respiratory rate, Irregular pulse rate, Shock, Cardiac arrest. The presence of hot, dry, flushed skin without any evidence of sweating is one of the important findings that differentiate heat stroke from other heat-related illnesses.

8 Preventing heat stress

Employers must conduct a heat stress assessment where a worker is, or may be, exposed to environmental conditions that could cause heat disorders. If a worker is exposed to such conditions, employers must develop and implement a heat stress exposure plan. As part of this plan, employers, supervisors, and workers must have a basic understanding of how heat affects the body if they are to prevent heat stress. Employers must provide adequate training and education to all workers at risk for heat stress, their immediate co-workers, and their supervisors. Training should include the following information:

- How heat stress develops
- Personal risk factors
- How to prevent heat stress
- How to recognize symptoms
- What a worker should do if he or she, or a co-worker, develops a heat disorder

If a worker is exposed to environmental conditions that could cause heat disorders, the employer must implement engineering controls to reduce exposure. If engineering controls are not practical, the employer must provide administrative controls (such as an appropriate work-rest cycle) or personal protective equipment if the equipment provides protection equally effective as administrative controls. Combinations of various control methods often provide the most effective protection from heat stress.

9 Conclusions

There is no reason why extreme thermal environments should have any direct effects on performance unless they alter the state of the individual. The heat stress on workers depends on many factors, which can be manipulated to ensure a state of thermal balance between a worker and his surroundings. The goal of the interventions should be to improve the thermal environment and prevent heat stress and strain.

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