Working in Heat

Health risks

The human body is designed to maintain a core body temperature of 37°C. A person carrying out physical activity (for instance while working) creates metabolic heat inside the body, which needs to be transferred to the person's external environment in order to avoid a dangerous increase of core body temperature. The body heat balance is determined by the 'six fundamental factors':

1. air temperature;
2. radiant temperature;
3. humidity;
4. air movement (wind speed);
5. clothing; and
6. the metabolic heat generated by human physical activity.

If cooling via sweating and convection (via contact with cooler air and air movement) is not sufficient, the metabolic heat generation needs to be reduced to avoid heat strain and heat stroke. This creates limits to the extent to which physical activity and work output can be maintained without rest periods.

When physical activity is high in a hot working environment, the worker is at risk of increased core body temperature (above 38°C), diminished physical work capacity, diminished mental task ability, increased accident risk and eventually heat exhaustion or heat stroke. The main factor underlying these effects is the increased core body temperature, but dehydration due to sweating and inadequate liquid intake is also of major importance.

The risk of heat-related illness varies from person to person. A person's general health also influences how well the person adapts to heat (and cold). Those with extra weight often have trouble in hot situations as the body has difficulty maintaining a good heat balance. Age (particularly for people about 45 years and older), poor general health, and a low level of fitness will make people more susceptible to feeling the extremes of heat.
Medical conditions can also increase how susceptible the body is. People with heart disease, high blood pressure, respiratory disease and uncontrolled diabetes may need to take special precautions. In addition, people with skin diseases and rashes may be more susceptible to heat. Substances -- both prescription or otherwise -- can also have an impact on how people react to heat.

Clothing also has a dramatic impact on the effects of heat exposure to workers. Sweat evaporates more effectively from exposed skin, therefore long sleeves, multiple layers and thick protective clothing can contribute to excessive heat strain even at temperatures much lower than those mentioned.

Workers who are suddenly exposed to working in a hot environment face additional and generally avoidable hazards to their safety and health. New workers and those returning from time away are especially vulnerable.

Heat exposure causes the following illnesses:

Heat edema is swelling which generally occurs among people who are not acclimatized to working in hot conditions. Swelling is often most noticeable in the ankles. Recovery occurs after a day or two in a cool environment.

Heat rashes are tiny red spots on the skin which cause a prickling sensation during heat exposure. The spots are the result of inflammation caused when the ducts of sweat glands become plugged.

Heat cramps are sharp pains in the muscles that may occur alone or be combined with one of the other heat stress disorders. The cause is salt imbalance resulting from the failure to replace salt lost with sweat. Cramps most often occur when people drink large amounts of water without sufficient salt (electrolyte) replacement.

Heat exhaustion is caused by loss of body water and salt through excessive sweating. Signs and symptoms of heat exhaustion include: heavy sweating, weakness, dizziness, visual disturbances, intense thirst, nausea, headache, vomiting, diarrhea, muscle cramps, breathlessness, palpitations, tingling and numbness of the hands and feet. Recovery occurs after resting in a cool area and consuming cool salted drinks.

Heat syncope is heat-induced giddiness and fainting induced by temporarily insufficient flow of blood to the brain while a person is standing. It occurs mostly among un-acclimatized people. It is caused by the loss of body fluids through sweating, and by lowered blood pressure due to pooling of blood in the legs. Recovery is rapid after rest in a cool area.

Heat stroke and hyperpyrexia (elevated body temperature) are the most serious types of heat illnesses. Signs of heat stroke include body temperature often greater than 41°C, and complete or partial loss of consciousness. The signs of heat hyperpyrexia are similar except that the skin remains moist. Sweating is not a good symptom of heat stress as there are two types of heat stroke – “classical” where there is little or no sweating (usually occurs in children, persons who are chronically ill, and the elderly), and “exertional” where body temperature rises because of strenuous exercise or work and sweating is usually present. Heat stroke and heat hyperpyrexia require immediate first aid and medical attention. Delayed treatment may result in damage to the brain, kidneys and heart. Treatment may involve removal of the victim's clothing and spraying the body with cold water. Fanning increases evaporation and further cools the body. Immersing the victim in cold water more efficiently cools the body but it can result in harmful overcooling which can interfere with vital brain functions so it must only be done under close medical supervision.

Some possible long term effects of heat exposure include;

Symptomatic exhaustion and clinical diseases, particularly kidney disease, can be the result of excessive dehydration. Certain other kidney, liver, heart, digestive system, central nervous system and skin illnesses are thought by some researchers to be linked to long-term heat exposure. However, the evidence supporting these associations is not conclusive.

Chronic heat exhaustion, sleep disturbances and susceptibility to minor injuries and sicknesses have all been attributed to the possible effects of prolonged exposure to heat.

A possible link between heat exposure and reproductive problems has been suggested. Data from laboratory experiments on animals have shown that heat stress may adversely affect the reproductive function of males and females. Exposure of males resulted in reduced rate of conception. Exposure of females caused disruption of the reproductive cycle until they became acclimatized to heat. When animals are simultaneously exposed to heat and toxic chemicals, the influence of heat exposure seems to accelerate the chemical reactivity.

In men, repeatedly raising testicular temperature 3 to 5°C decreases sperm counts. There is no conclusive evidence of reduced fertility among heat-exposed women. There are no adequate data from which conclusions can be drawn regarding the reproductive effects of occupational heat exposure at currently accepted exposure limits.

Maximum working temperature

Unfortunately, there is no maximum temperature for workers, although the *WHS Regulations 2011 c40 (f)* states;

"A person conducting a business or undertaking at a workplace must ensure, so far as is reasonably practicable, workers carrying out work in extremes of heat or cold are able to carry out work without risk to health and safety"

The lack of a legal maximum is a major omission, and many workers are forced to work in temperatures which are not only uncomfortable, but which could damage their health or result in death.

When the air temperature is close to or warmer than normal body temperature (37°C), cooling of the body becomes more difficult. Blood circulated to the skin cannot lose its heat. Sweating then becomes the main way the body cools off. But sweating is effective only if the humidity level is low enough to allow evaporation and if the fluids and salts that are lost are adequately replaced.

In moderately hot environments the body "goes to work" to get rid of excess heat so it can maintain its normal body temperature. The heart rate increases, to pump more blood through outer body parts and skin so that excess heat is lost to the environment, and sweating occurs. These changes impose additional demands on the body. Changes in blood flow and excessive sweating reduce a person's ability to do physical and mental work. Manual work produces additional metabolic heat and adds to the body heat burden. When the environmental temperature rises above 30°C, it may interfere with the performance of mental tasks.

If the body cannot get rid of excess heat, it will store it. When this happens, the body's core temperature rises and the heart rate increases. As the body continues to store heat, the person begins to lose concentration and has difficulty focusing on a task, may become irritable or sick, and often loses the desire to drink. The next stage is most often fainting and even death if the person is not cooled down.

No radiant heat loss occurs when the temperature of surrounding objects is the same or more as skin temperature (35°C). When the temperature exceeds 35°C and the relative humidity is above 70%, the use of fans will increase worker's temperature because there will be little evaporation of sweat.

In hot weather, the body produces sweat, which cools the body as it evaporates. As the humidity or the moisture content in the air increases, sweat does not evaporate as readily. Sweat evaporation stops entirely when the relative humidity reaches about 90%. Under these circumstances, the body temperature rises and may cause illness.

The Code of Practice – *Managing the work environment and facilities,* states;

"Optimum comfort for sedentary work is between 20 and 26 degrees Celsius, depending on the time of year and clothing worn. Workers involved in physical exertion usually prefer a lower temperature range."

When the temperature or humidity rises above the optimal ranges for comfort problems can arise.

Measures currently in place to control exposure to extreme heat only use administrative controls or at best engineering. Regulators and employers are ignoring the hierarchy of control and not eliminating the risk to workers at all. The duty of care requires them to supervise and monitor conditions at the workplace and relying on workers to take rests as needed or remove themselves from unsafe work does not meet these obligations.

The measures generally applied across industry are largely reactive and they need to be implemented at temperatures well below those of extreme days. The thresholds in place are absolute maximums and in no way imply that works are completely safe in conditions below those stated, full workplace consultation needs to take place for individual workplaces.

The frequency of extreme heat days, and the time of day at which the thresholds are reached is in effect largely minimal.

Fatigue is one of the most common symptoms of exposure to heat, and is also the major factor in construction accidents.

The effects of exposure to extreme heat are not only evident in direct incidents; it can also play a role in contributing workplace accidents, and/or ongoing health problems in the days or years to come.

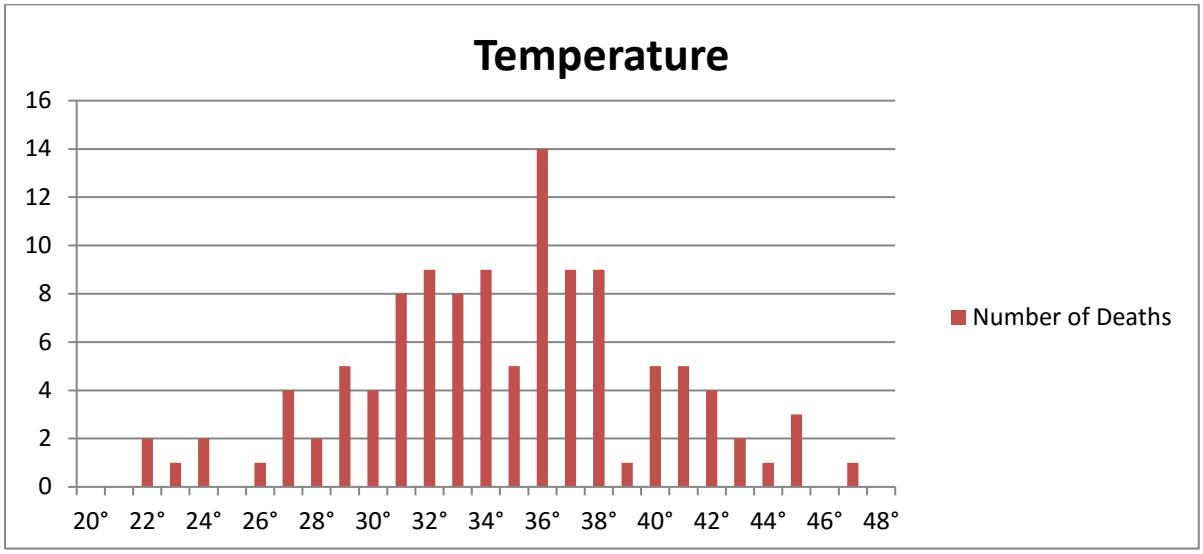
References

Canadian Centre for Occupation Health & Safety
Workplace heat stress, health and productivity – an increasing challenge for low and middle-income countries during climate change - Tord Kjellstrom, Ingvar Holmer, and Bruno Lemke
United States Department of Labor – Occupational Safety & Health Administration (OSHA)
Heat Stress Awareness Guide - Occupational Health and Safety Council of Ontario (OHSCO)
WorkCover NSW - Code of Practice on managing the work environment and facilities
Dr Peggy Trompf – Industrial Health Matters

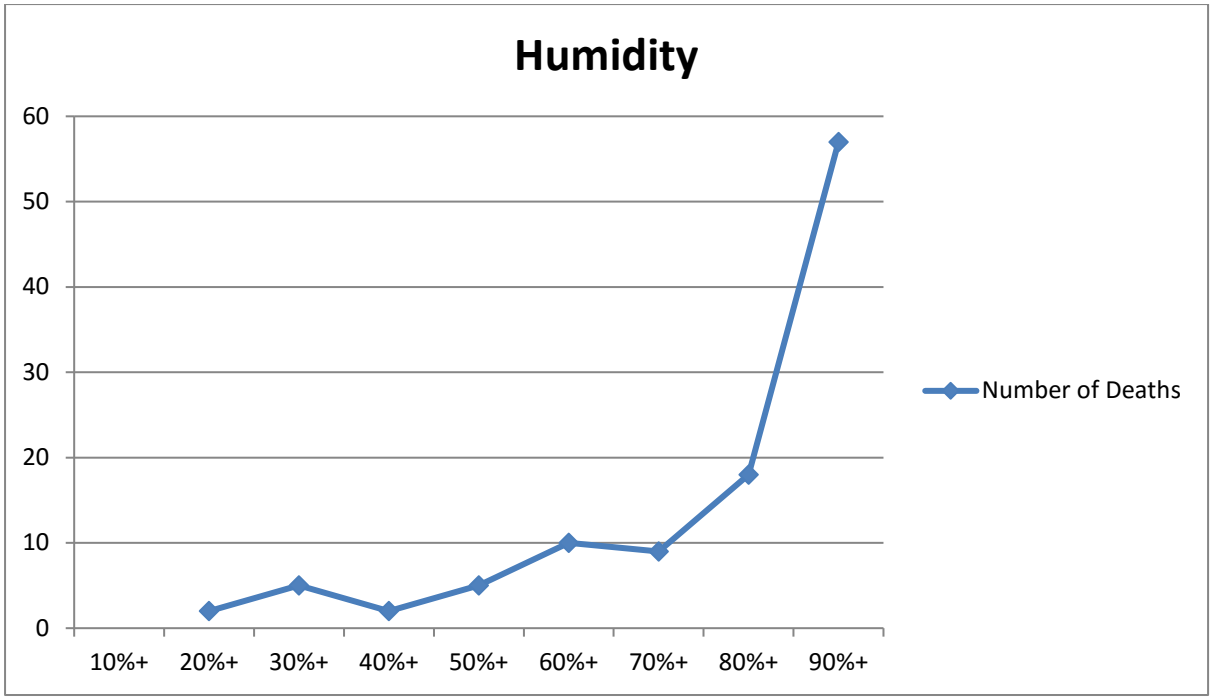
Appendix 1

Statistics

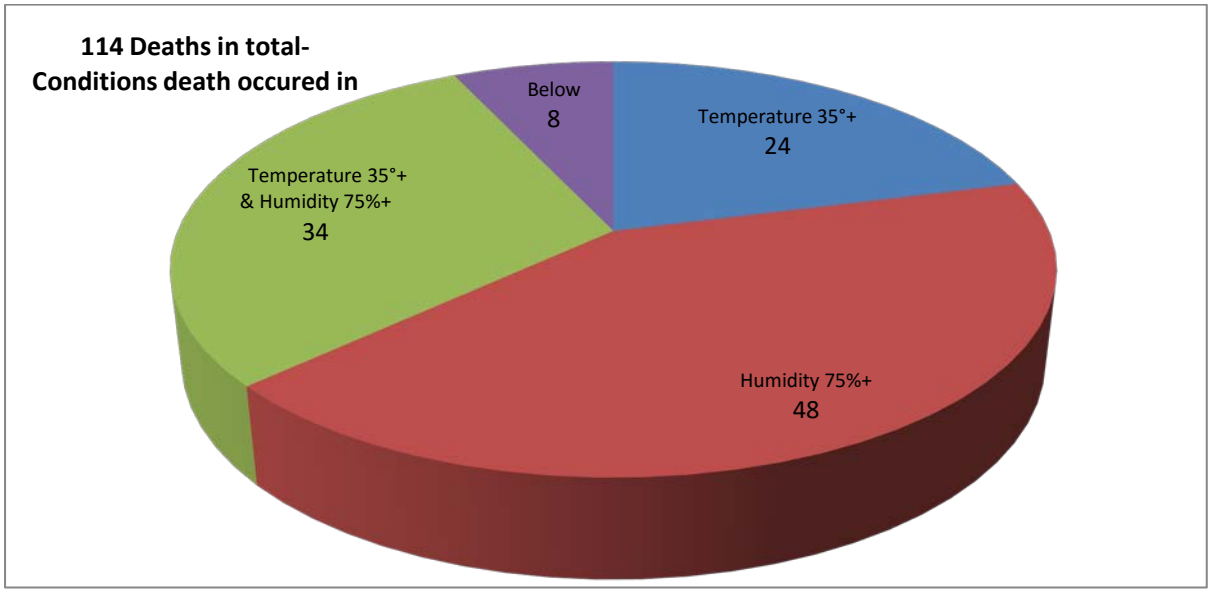
In the USA there have been 114 (recorded) heat related deaths at work since 2008.



Of those, 57 were above the 35°C threshold, with the highest number being of deaths occurring at 36°C.



82 were in humidity levels above the 75% threshold, with 57 occurring above 90% alone.



And 34 were in conditions where both thresholds were exceeded. Only 8 occurred where neither threshold was reached, all of which were workers performing strenuous physical activities in outdoor environments.