When hard work is performed in a hot environment, blood is sent to the skin to cool the body, primarily through evaporation of sweat. As sweating continues, often at a rate of more than 1 liter per hour, the body loses lots of fluid. That can compromise heart and circulatory function and the ability to work. If fluids are not replaced, the temperature-regulating process begins to break down, work becomes impossible, and the possibility of life-threatening heat stroke increases dramatically.

Heat Disorders

Heat stress disorders include heat cramps, heat exhaustion, and heat stroke.

Heat cramps are involuntary muscle contractions caused by failure to replace fluids or electrolytes, such as sodium and potassium. Cramps can be relieved by stretching and by replacing fluids and electrolytes.

Heat exhaustion is characterized by weakness, extreme fatigue, nausea, headaches, and a wet, clammy skin. Heat exhaustion is caused by inadequate fluid intake. It should be treated by resting in a cool environment and replacing fluids and electrolytes.

Heat stroke is a medical emergency caused by failure of the body’s heat controls. Sweating stops and the body temperature rises precipitously. Heat stroke is characterized by hot dry skin, a body temperature above 106.8 °F (41 °C) mental confusion, loss of consciousness, convulsions, or even coma. Send for medical help at once and begin rapid cooling with ice or cold water, fanning the victim to promote evaporation. Treat for shock if necessary. For rapid cooling, partially submerge the victim’s body in cool water.

Prevention

You can prevent the serious consequences of heat disorders by improving your level of fitness and becoming acclimated to the heat.

Maintaining a high level of aerobic fitness is one of the best ways to protect yourself against heat stress. The fit worker has a well-developed circulatory system and increased blood volume. Both are important to regulate body temperature. Fit workers start to sweat sooner, so they work with a lower heart rate and body temperature. They adjust to the heat twice as fast as the unfit worker. They lose acclimatization more slowly and regain it quickly.

Acclimatization occurs in 5 to 10 days of heat exposure as the body:

- Increases sweat production
- Improves blood distribution
- Decreases the heart rate, and lowers the skin and body temperatures.

You can acclimatize by gradually increasing work time in the heat, taking care to replace fluids, and resting as needed. You maintain acclimatization with periodic work or exercise in a hot environment.

On the Job

The heat stress chart illustrates how temperature and humidity combine to create moderate or high heat stress conditions.

Be alert for heat stress when radiant heat from the sun or nearby flames is high, the air is still, or when you’re working hard, creating lots of metabolic heat.

Some organizations use the WBGT Heat Stress Index. The index uses dry bulb, wet bulb, and black globe temperatures. The temperatures are weighted to indicate the impact of each measure on the worker:

- Wet bulb (humidity) accounts for 70%
- Black globe (radiant heat and air movement) accounts for 20%
- Dry bulb (air temperature) accounts for 10%

Heat stress indexes do not take into account the effects of long hours of hard work, dehydration, or the impact of personal protective clothing and equipment.

When heat stress conditions exist, you must modify the way you work or exercise. Pace yourself. There are individual differences in fitness, acclimatization, and heat tolerance. Push too hard and you’ll be a candidate for a heat disorder. When possible:

- Avoid working close to heat sources
- Do harder work during cooler morning and evening hours
- Change tools or tasks to minimize fatigue
- Take frequent rest breaks as you work.

Most important, maintain hydration by replacing lost fluids.

Hydration

Studies on wildland firefighters indicate that fire suppression activities generate about 7.5 kilocalories of heat each minute worked, or over 400 kilocalories for each hour. Additional heat (about 180 kilocalories per hour) comes from the environment and the fire. The total heat load amounts to 580 kilocalories per hour (400 + 180 = 580).

Complete evaporation of 1 liter of sweat removes 580 kilocalories of heat. That means that a firefighter needs to evaporate about 1 liter (slightly more than 1 quart) of sweat during each hour of work. Maintaining body fluids is essential for sweating. That means you must hydrate before, during, and after work.
Thirst always underestimates fluid drinking to replace fluid losses. The reason is that thirst is enhanced when fluids contain sodium and potassium, or when foods with these electrolytes are consumed along with the fluid.

After work, you need to continue drinking to replace fluid losses. Thirst always underestimates fluid needs, so you should drink more than you think you need. Rehydration is enhanced when fluids contain sodium and potassium. After prolonged arduous work, the body weight can decrease 1 to 2% due to fluid loss in the urine. Avoid alcoholic drinks. They also cause dehydration. Avoid extra layers of clothing that insulate, restrict air movement, and contribute to heat stress.

Individual Differences

Individuals differ in their response to heat. Some workers are at greater risk for heat disorders. The reasons include inherited differences in heat tolerance and sweat rate. Excess body weight raises metabolic heat production. Illness, drugs, and medications can also influence your body’s response to work in a hot environment. Check with your physician or pharmacist if you are using prescription or over-the-counter medications, or if you have a medical condition.

You should always train and work with a partner who can help in the event of a problem. Remind each other to drink lots of fluids and keep an eye on each other. If your partner suffers a heat disorder, start treatment immediately.

Summary

Prevention

- Improve or maintain aerobic fitness
- Acclimate to the heat

On the job

- Be aware of conditions (temperature, humidity, air movement)
- Take frequent rest breaks
- Avoid extra layers of clothing
- Pace yourself

Hydrate

- Before work—drink several cups of water, juice, or a sport drink
- During work—take frequent fluid breaks
- After work keep drinking to ensure rehydraation
- Remember, only you can prevent dehydration

Partners

- Always work or train with a partner

* Sport drinks with carbohydrate and electrolytes encourage fluid intake, provide energy, and diminish urinary water loss. The carbohydrate also helps maintain immune function and mental performance by increasing urine production.

For more information consult: Sharkey, Brian J., Fitness and Work Capacity (order NFES No.1596), available from NIFC c/o Great Basin Cache Supply, 3833 South Development Ave., Boise, ID 83705

Wildland firefighting is arduous work. Shifts are long, often in steep terrain and at higher elevations. The weather is usually hot and dry, and the fire increases exposure to heat. This brochure focuses on the risks of heat stress, and what the firefighter should do to minimize those risks.

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