HEAT STRESS AND FOOTBALL

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It's not easy to keep cool when the heat is on

Football is the most popular sport in the world and is played by all kinds of people, regardless of their age, gender or physical condition. The physical aspects of football have been studied most intensively in adult male players, and a substantial body of information is available for this section of the population. In a typical football match, elite players cover a total distance of 9–12km, with an average aerobic load of 75% of their maximum oxygen uptake (VO_2 max) and a heart rate of about 80–90% of its maximum. It is clear that performance levels, and thus the outcome of matches, may be determined by the ability to perform repeated short bursts of high-intensity work in an endurance context, and the effects of heat stress or dehydration, either separately or in combination, may contribute to a decline in performance levels during a match.[1]

Stressful environmental conditions can pose numerous problems for athletes. Exertional heatstroke (EHS) is often associated with physical activity in a hot and humid environment, with incidence of EHS being correlated with rises in ambient air temperatures and humidity.

1. Extreme environmental heat places significant stress on the body's ability to perform, while thermoregulatory responses occur in various internal organs.
2. These responses include mobilising nutrients and electrolytes and maintaining an appropriate equilibrium within the body in terms of fluids, body temperature, pH and blood pressure. If the organs' internal systems do not respond appropriately, the athlete may develop a serious and potentially catastrophic medical condition.

To guard against EHS during athletic events, the American College of Sports Medicine (ACSM) has studied the effects of heat stress and made specific recommendations regarding participation in sport in stressful environments. Those recommendations consist of guidelines that measure and define the severity of heat stress using a wet bulb globe temperature (WBGT) index. On the basis of the WBGT at the time of the event, the ACSM also makes recommendations regarding the type, duration and frequency of exercise sessions on that particular day, the frequency of hydration and rest breaks, and whether or not the activity should be moved to a different time of day or cancelled altogether. Football is played in many different environments, and in some parts of the world competitive matches are played in challenging conditions, with temperatures exceeding 30C and a high degree of relative humidity.[2]

Hyperthermia imposes extra thermal stress on the player in addition to the usual physical stress. The core temperature of the player's body rises, the sweat rate increases as physiological defence mechanisms are used to dissipate the heat and reduce thermal stress, and fatigue ensues. The combination of an increase in the body's core temperature and progressive dehydration causes the player to become increasingly exhausted, leading to fatigue and, more importantly, the potential for adverse effects on the player's health.[3]

Testing of players at the end of a recent Australian rules football game that was played at an ambient temperature of 38C revealed a mean core temperature of 39.9C, so some individual values would have been well in excess of 40C.

The thermal stress that players face during a match has typically been estimated by simulating match conditions in a laboratory or a controlled indoor environment. However, football involves frequent fluctuations between high and low-intensity exercise, with a change of activity every four to six seconds, so the physical activity pattern of a football match may be quite different from the activities typically performed in laboratories. In addition, measurements made after a game may not truly reflect the changes in core temperature that occurred during the game.[4]

To reduce the number of heat-related illnesses, the National Collegiate Athletic Association recently introduced a mandatory five-day acclimatisation period. However, some research indicates that even longer acclimatisation may be needed. Several authors have suggested that an athlete requires approximately 10 to 14 days to fully acclimatise to environmental conditions and that the specific WBGT may not play a significant role in the incidence rate of heat cramps. Increasing the mandatory acclimatisation period in hot environments may reduce the incidence of exertional heat illnesses (EHIs). Based on the data collected, results indicate that most reported EHIs occur during the first three weeks of training in August, with a dramatic decline in incidence rates thereafter. This coincides with the beginning of football training and double training sessions. It appears that once double training sessions have ended, the incidence rate falls. The majority of the reported EHIs were heat cramps, which are typically associated with a lack of acclimatisation or conditioning.

Dehydration reduces endurance exercise performance, decreases time to exhaustion and increases heat storage[5]. EHS is characterised by rectal temperatures in excess of 40C at collapse and changes to the central nervous system. The following factors increase the risk of EHS or exertional heat exhaustion:

- obesity;
- low level of physical fitness;
- lack of acclimatisation to heat;
- dehydration;
- previous history of EHS;
- sleep deprivation;
- sweat gland dysfunction;
- sunburn;
- viral illness;
- diarrhoea;
- certain medication.

Physical training and cardiorespiratory fitness reduce the risk of EHS. In the event of EHS, immersion in cold water is the fastest way to cool the whole body down and produces the lowest morbidity and mortality rates. When immersion in water is not possible, placing ice packs and towels or sheets soaked in freezing cold water on the head, trunk and extremities results in effective – but slower – cooling of the body.

Dehydration and a high body mass index both increase the risk of exertional heat exhaustion, while 10–14 days of exercise training in the heat will improve acclimatisation to the heat and reduce the risk. EHS casualties may return to training and competitive matches when they have re-established their tolerance of heat. Aural, oral, skin, temporal and axillary temperature measurements should not be used to diagnose EHS or distinguish it from exertional heat exhaustion.

Early symptoms of EHS include clumsiness, stumbling, headaches, nausea, dizziness, apathy, confusion and impairment of consciousness. Training and competitive matches should be altered on the basis of air temperature, relative humidity, exposure to the sun, degree of acclimatisation to the heat, age and equipment requirements, by reducing the duration and intensity of exercise and by altering the kit worn.

Educating athletes, coaches, administrators and medical staff (especially on-site personnel and local emergency response teams) can help with the reduction, recognition and treatment of heat-related illness. Athletes should be advised about the importance of being well-hydrated, well-fed, well-rested and acclimatised to the heat. Athletes should also be told to monitor each other for signs of subtle changes in their performance or behaviour, making them responsible for monitoring each other's well-being[6].

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2 American College of Sports Medicine position stand: Exertional heat illness during training and competition, *Medicine & Science in Sports & Exercise*, March 2007, Volume 39, Issue 3, 556-572.

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