Exercise performance in the heat: possible brain mechanism and thermoregulatory strategies

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In many parts of the world major sporting events are held in extremely hot conditions. It is well accepted that the human body is able to thermoregulate efficiently during exercise in a range of cool to moderate ambient conditions. However, thermoregulation has been shown to be more difficult during exercise in hot conditions. In recent studies, it has been suggested that the attainment of a critically high body core temperature influences brain activity, cerebral metabolic and neurotransmitter changes; which may also lead to a reduced central nervous system drive to skeletal muscle for exercise performance. As a result, high body core temperature is proposed as one of the main factors limiting endurance performance. The hypothalamus is the critical thermoregulatory site in the brain during exercise and neurotransmission in this region are involved in temperature regulation. The physiological mechanisms involved with hyperthermia-induced central fatigue may appear to be influenced by neurotransmitter activity of catecholamine. In order to successfully improve exercise performance through prevention of hyperthermia in hot conditions, several strategies including fluid intake, pre-cooling and other cooling applications have been applied. This review focuses on the possible brain mechanisms at high body temperature that influence exercise performance, and the variable strategies for preventing hyperthermia during exercise in the heat.

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To optimize performance, the exercise-heat stimulus should as closely as possible simulate the expected climate-exercise conditions during competition. However, this may require a gradual increase in the climatic heat stress, exercise intensity and duration and there may be trade-offs made by the athlete. For example, it has been shown that low-intensity long duration exercise elicits similar heat acclimatization benefits (i.e., reduced exercising heart rate, core temperature and metabolism) to that of moderate-intensity short-duration exercise (Houmard et al., 1990). Human circulatory and thermoregulatory adaptations with heat acclimation and exercise in a hot, dry environment. J. Physiol. 460:467-485. In humans, the thermoregulatory response with the greatest capacity for heat loss during environmental heat exposure and physical activity is the evaporation of sweat [29]. The fact that SkBF responses during exercise in the heat are diminished to a much greater extent in older individuals compared to younger individuals, thereby negatively affecting heat content distribution and possibly even heat loss capacity in this population, lends some support to this suggestion [25]. Over the past several years, a number of researchers have examined the mechanisms underlying age-related impairments in cutaneous vasomotor control [9, 10, 13, 26, 38, 53–60].

1. To examine the influence of the rate of heat loss on the magnitude of post-exercise hypotension, subjects were exposed to three different environmental conditions during recovery from bicycle exercise. 2. When subjects recovered in warm conditions. 2. When subjects recovered in warm conditions both core temperature (measured in the external auditory meatus) and mean skin temperature were significantly elevated 60 min after the cessation of exercise. This attenuation of heat loss was associated with a significant reduction in post-exercise mean arterial pressure. 3. In contrast, when subjects recovered in neutral or cool conditions both core temperature and mean arterial pressure had returned to baseline levels 60 min after exercise.