THE EFFECTS OF HEAD AND NECK COOLING ON THERMOREGULATION, PACE SELECTION, AND PERFORMANCE

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The head and neck comprise only ~10% of total body surface area but have various physical and physiological properties favouring high heat transfer. Thus, cooling the head prior to or during exercise may be an efficient and effective means of reducing heat strain, as has been observed during mild exercise in the heat. Attenuating rises in brain or head skin temperatures might reduce discomfort and facilitate higher exercise intensities and body temperatures. However, strong cold-afferent supply from cutaneous thermoreceptors and/or a decrease in hypothalamic temperature due to selective cooling of the head could also provide false representation of the body's true thermal status and result in inappropriate physiological and behavioural thermoregulatory responses. This would accelerate heat storage and possibly lead to heat injury. The purpose of this study was to determine the physiological, psychophysical and performance-related effects of head and neck cooling during rest and exercise in a hot environment. Fourteen male distance runners (mean ±SD; $\dot{V}_{O_2max}$, 62 ±5 mL•kg^{-1}•min^{-1}; mass, 76 ±6 kg; A_D, 2.0 ±0.1 m^2; age, 24 ±4 y) participated as voluntary subjects. After two full familiarisation sessions, each subject completed four testing sessions (one per week) in an environmental chamber (33°C and 55% rh), in balanced order. Each session consisted of 60-min seated rest followed by 30-min running at ~60% $\dot{V}_{O_2max}$ and then 15-min self-paced running to achieve maximum possible distance (without performance cues). The four sessions were identical except for the application and timing of head cooling: (1) No cooling during rest or exercise (control); (2) No cooling during rest but cooling throughout exercise; (3) Cooling throughout rest but not during exercise; and (4) Cooling throughout rest and exercise. The head was cooled using a water-perfused hood (1.1 L•min^{-1}, 1°C inlet temperature) containing 6.3-m PVC tubing. Body temperature was measured from the core (T_c = rectal+oesophageal/2) and skin (9 sites), while sweat rate was determined by mass loss. Heat gain by the cap during rest (143 W) approximated the metabolic heat production (143 ±14 W, from indirect calorimetry). It increased (ie. $P<0.05$) during exercise, becoming higher in exercise-only cooling (178 W) than in rest+ exercise cooling (157 W, $P<0.05$), but represented lower proportions of metabolic heat production (16 and 14%, respectively). Seated rest without head cooling led to increased T_c (0.10-0.15°C) and heart rate (5 ±1 b·min^{-1}), such that exercise began at lower T_c (by 0.15-0.20°C) and heart rate (by 5-8 b·min^{-1}) in the precooled compared with uncooled conditions. At the end of exercise, T_c was higher in control than in all three head-cooling conditions (by 0.20-0.25°C), but heart rate was equivalent between conditions (173 ±11 b·min^{-1}). Head cooling led to lower perceived temperature and improved thermal comfort of both the head and body during rest, except that the improvement in head comfort was not significant ($P=0.06$). All cooling conditions improved head comfort at the end of exercise, relative to control, but body comfort and perceived head temperature were only improved when cooling was applied during exercise. Perceived exertion increased during each exercise period and was equivalent between conditions. Sweat rate was lower during rest in the head cooling conditions (by 0.06 ±0.06 L·hr^{-1}). The 15-min run distance was higher with full-time cooling than with no cooling (3.3 ±3.4%) or precooling only (2.5 ±3.0%), and showed a similar trend against exercise-only cooling (2.3 ±2.9%, $P=0.08$). Despite a limited surface area, cooling the head reduced heat-related strain (core temperature, heart rate and sweat rate) during rest. This partially attenuated physiological (T_c) and psychophysical (head comfort) strain during subsequent exercise, but did not improve performance (over 15-min, or ~4000 m). Head cooling before and during exercise reduced actual and perceived thermal strain and improved performance.

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