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Effect of hand cooling on body temperature, cardiovascular and perceptual responses during recumbent cycling in a hot environment

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Abstract

Exercise in hot environments increases body temperature and challenges the function of cardiovascular, metabolic and thermoregulatory systems. Elevated body temperature as a consequence of prolonged and/or intense exercise impairs athletic performance and increases the risk of heat illness and serious medical conditions. Pre-exercise cooling techniques have been used to lower body temperature and increase heat storage capacity during exercise. Head, neck and wrist cooling have also been employed to reduce physiological strain in hot environments. Although the majority of these methods have proven useful, some are impractical for use during exercise when heat strain is most pronounced. Hand cooling during exercise has the potential to alleviate these impracticalities and attenuate increases in body temperature due to the hands large surface to mass ratio, low metabolic heat production, large blood supply and rapid cooling rates. Reductions in body temperature after bouts of exercise and improvements in exercise performance have been observed using various hand cooling protocols. However, the effectiveness of hand cooling during exercise in a hot environment and the mechanisms of action are unclear. The purpose of the study was to quantify physiological and perceptual responses to hand immersion in water during recumbent cycling in a hot environment. In a randomised control design 7 well-trained males (body mass 79.8 s 6.3 kg; stature 182 s 5 cm; age 23 s 3 years; recumbent cycling $\dot{V}O_{2peak}$ 41 s 5 ml·kg^{-1}·min^{-1}) who were naïve to the study aims provided informed consent to participate in 3 trials. Participants immersed their hands in 8, 14 and 34°C water whilst cycling at an intensity (W) equivalent to 50% $\dot{V}O_{2peak}$ for 60 min in an environmental chamber maintained at 35°C 50% relative humidity. Intestinal and 4-site mean skin temperature and heart rate were monitored continuously and mean-averaged over 5 minute intervals. Rating of perceived exertion and thermal strain were assessed every 5 minutes. Data was assessed for normality and homogeneity of variance. The likelihood (% chance) of between group differences was assessed using a magnitude-based approach, Cohen's standardised difference score (*d* = 0.20 small, 0.5 moderate and 0.8 large effect) and 90% confidence intervals for [*d*]. Change in intestinal temperature was likely (84%) less in 8°C; 0.43 s 0.16°C versus 34°C; 0.55 s 0.16°C after 15 min; *d* = 0.73 [-0.19 to 1.65] and very likely (98%) less in 8°C; 0.78 s 0.28°C versus 34°C; 1.22 s 0.16°C after 40 min *d* = 1.36 [0.47 to 2.25]. Change in mean skin temperature was likely (87%) less in 8°C; -0.05 s 0.39°C versus 34°C; 0.31 s 0.46°C; *d* = 0.81 [0.09 to 1.71] after 5 min, very likely (98%) less after 15 min; -0.09 s 0.72°C versus 0.77 s 0.30°C; *d* = 1.24 [0.45 to 2.03] and onwards to cessation of exercise. Percentage of peak heart rate was likely (94%) lower in 8°C; 87 s 4% versus 34°C; 90 s 5% from 25 min onwards; *d* = 0.69 [0.18 to 1.20]. After 5 min of exercise rating of perceived exertion was likely (77%) lower in 8°C; 12.6 s 1.0 versus 34°C 13.4 s 1.7; *d* = 0.61 [-0.36 to 1.57] but was likely similar from 25 min onwards. Perception of thermal strain was likely (92%) lower in 8°C; 6.5 s 0.5 versus 34°C; 7.2 s 0.4 after 5 min exercise; *d* = 0.81 [0.09 to 1.71] and was almost certainly (>99%) lower; 7.3 s 0.7 versus 8.0 s 0.7 for the remainder of the trial; *d* = 1.21 [0.65 to 1.77]. Similar beneficial effects were observed for 14°C versus 34°C immersion but the magnitude of the effects was smaller than 8°C immersion. Small-to-moderate differences were observed between 8°C and 14°C immersion. The findings suggest that hand cooling during fixed moderate-intensity cycling in a hot environment has the potential to alleviate increases in body temperature, cardiovascular demand and perceptions of exertion and thermal strain. Greatest effects were observed when the hands were immersed in 8°C water compared with 14°C. Augmented heat loss at the palm-water surface might enable cooler blood to return to core and shell regions; increasing the thermal gradient between active tissue and blood thus improving internal heat transfer, maintaining a wide core to skin temperature gradient and reducing heat storage. Limiting the increase in body temperature might have lowered cardiovascular demands by reducing the requirement for cutaneous vasodilation thus lowering physiological strain. These combined effects are manifested in lowered perceptions of exertion and thermal strain. The findings from this study suggest that endurance exercise in hot environments might be improved by hand cooling and future research should investigate its effectiveness during cycling and running performance.

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