

28th ECSS Anniversary Congress, Paris/France, 4-7 July 2023

Combined effects of hyperthermia and mental fatigue impairs aerobic exercise capacity in highly trained athletes in the heat.

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INTRODUCTION:

Combined effects of mental fatigue by a prolonged cognitive task and exposure to heat stress would impair exercise capacity in the heat. However, in the focus of thermoregulatory responses, it is not unclear whether the effects of elevation in core temperature (hyperthermia) or heat exposure without elevation in core temperature during performed cognitive task induce to impair exercise capacity. The purpose of this study was to investigate the effects of differences in core temperature by exposure to heat stress in addition to a mental fatigue on aerobic exercise capacity in the heat.

METHODS:

Seven highly trained athletes (age: 22 ± 1 years, height: 173.2 ± 2.4 cm, body mass: 67.11 ± 5.2 kg, maximal oxygen uptake: 63.7 ± 7.1 mL/kg/min) completed two experimental conditions: hyperthermia (HYP) and control (CON). Participants were conducted AX-Continuous Performance Task (AX-CPT) and Stroop tasks to induce mental fatigue during a warm water immersion at 40 °C (HYP) or a seated in chamber at 35 °C and 60% relative humidity (CON) for 45 min before exercise. Thereafter, participants performed running trial at 80% maximal oxygen uptake until voluntary exhaustion in the same chamber as the CON.

RESULTS:

Exercise time to exhaustion was significantly lower in the HYP trial (8.9 ± 3.3 min) than that of the CON trial (12.6 ± 3.3 min; $p = 0.028$). Rectal temperature at the end of tasks in the HYP trial increased by 0.86 ± 0.26 °C ($p = 0.001$) and was significantly higher (37.69 ± 0.18 °C) than that of the CON trial (36.96 ± 0.13 °C; $p = 0.001$), albeit no significant differences in mean skin temperature ($p = 0.610$). Heart rate at the end of tasks in the HYP trial was significantly higher (98 ± 18 bpm) than that of the CON trial (76 ± 11 bpm; $p = 0.021$). Self-reported mental fatigue using visual analog scale was significantly higher after tasks in both trials ($p < 0.001$), but no significant differences between trials (HYP: 5.3 ± 2.5 , CON: 6.1 ± 2.2 , $p = 0.349$). Throughout trial, salivary cortisol concentration and perceptual responses (perception of effort and thermal sensation) were not affected by hyperthermia.

CONCLUSION:

This study demonstrated that combined effects of elevation in core temperature (hyperthermia) and mental fatigue in highly trained athletes causes to impair exercise capacity in hot environments compared to mental fatigue during heat exposure without elevation in core temperature. This observation suggests that athletes with mental fatigue should avoid elevation in core temperature equivalent to hyperthermia before exercise to attenuate impairment in subsequent endurance exercise performance in hot environments.

Topic: Physiology

Presentation: E-poster

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