

暑熱下持続的運動時における 呼吸循環応答に及ぼす睡眠不足の影響

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Effect of Sleep Deprivation on Cardiorespiratory Responses During Prolonged Exercise in the Heat

by

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ABSTRACT

Hyperthermia during exercise leads to increases in ventilation independently of metabolic factors, resulting in hypocapnia and cerebral hypoperfusion. This study examined the effects of sleep deprivation on body temperature and cardiorespiratory responses during exercise in the heat. Six male subjects performed a cycle exercise at 50% of peak oxygen uptake in the heat (37°C ambient temperature and 50% relative humidity) until their esophageal temperature (T_{es}) reached 39°C or they could no longer continue the exercise. Normal sleep (control trial) or ~28 h of wakefulness (sleep loss trial) preceded the exercise-heat test. T_{es} , minute ventilation (\dot{V}_E), respiratory gases, sweat rate (ventilated capsule method) and skin blood flow (laser-Doppler), heart rate and arterial blood pressure during the exercise were measured

continuously. Exercise duration did not differ between trials ($P > 0.05$). T_{es} at rest tended to be lower in the sleep loss than control trial, and it during exercise and at the end of exercise did not differ between trials ($P > 0.05$). Plotting ventilatory and thermoregulatory responses against T_{es} showed that \dot{V}_E at T_{es} of 38.8°C was higher in the sleep loss than control trial ($P < 0.05$), and the sensitivity of \dot{V}_E to rising T_{es} (slope of the T_{es} - \dot{V}_E relation) tended to be greater in the sleep loss than control trial. Sleep loss did not affect the T_{es} thresholds for sweating and cutaneous vasodilation and the sensitivities of the responses ($P > 0.05$). These results indicate that during prolonged exercise in the heat, sleep deprivation can accelerate hyperthermia-induced hyperventilation during prolonged submaximal exercise in the heat.

要 旨

暑熱下持続的運動時の体温および呼吸循環反応に及ぼす断眠の影響を検討した。6名の健常男性を対象とし、暑熱下での中強度 ($50\% \dot{V}O_{2peak}$) 一定負荷持続的運動を、通常睡眠 (Control 条件) および約 28 時間の覚醒を伴う断眠 (Sleep loss 条件) の 2 条件下で実施した。運動継続時間に条件間で違いはみられなかった。食道温 (T_{es}) は安静時において Sleep loss 条件で低い傾向を示したが、運動時および運動終了時の T_{es} に差はみられなかった。 T_{es} に対して換気および発汗・皮膚血流反応をプロットし、深部体温上昇に伴う換気亢進および体温調節反応を検討した。その結果、深部体温上昇に対する換気亢進の感受性 (T_{es} と換気量 (\dot{V}_E) の関係における回帰直線の傾き) は、Control 条件よりも Sleep loss 条件で高い傾向を示し、さらに同一 T_{es} 時の \dot{V}_E は 38.8°C において Sleep loss 条件で有意に高値を示した。発汗開始および皮膚血管拡張の T_{es} 閾値ならびに T_{es} 上昇に対する各反応の感受性に条件間で差はみられなかった。これらの結果から、暑熱下での最大下持続的運動時において、一過性の断眠によって体温上昇時の換気亢進反応が増大する可能性が示唆された。