

PHYSIOLOGICAL AND PSYCHOMOTOR PERFORMANCES IN HYPOXIC CONDITIONS AFTER HEAT ACCLIMATION

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INTRODUCTION

Environmental stressors have a significant effect on human performance. Therefore, developing efficient adaptation methods to various environmental impacts is a challenge.

It has been shown that adaptation to one environmental stressor can also induce augmented protective responses to other stressors. This phenomenon, which is defined as cross tolerance, may exist without prior exposure to new stressors, due to activation of common protective pathways. Heat acclimation is an adaptive physiological response that results from a daily exposure to exercise in hot environment for at list 10 days. It has also been shown that heat acclimation is involved in certain molecular adaptations that are associated with protection against tissue injuries during exposure to heat stroke (1). Hypoxia is another environmental factor that has a significant limitation on performance for those who operate in high altitudes. It has been shown that heat and hypoxia have common effects on both molecular and metabolic responses (2). We, therefore, hypothesized that prior heat acclimation may reduce the physiological strain and improve the psychomotor performances in hypoxic conditions through the cross tolerance mechanism.

METHODS

Eight young healthy males (23 years old) participated in this study. All the participants went through medical exams and signed an informed consent. The study was approved by the Ethics Committee of the Sheba Medical Center. On the first day of the study the participants performed three psychomotor tests; Visual Vigilance Task, Four Choice Reaction Time (3) and a Posture Test (Graybiel-Fregly Posture Test) (4). They all performed a VO₂ max test during which lactate threshold was also detected. During the second day of the study the participants went through the same psychomotor tests and the lactate threshold test in hypoxic chamber with oxygen concentrations of 15.6% which are similar to 2400 m altitude above sea level. During exposure to hypoxic conditions blood saturation was monitored continuously.

Since the third day of the study all the participants went through a 12-day heat acclimation process. The heat acclimation process included a daily 2-hr exercise in a climatic chamber in 40°C and 40% relative humidity. The exercise consisted walking on a treadmill at a pace of 5 km/h and 2% inclination. The participants were dressed in shorts and tennis shoes. Body core

(rectal) temperature (T_{re}) and heart rate (HR) were monitored continuously. Fluid balance was assessed from differences in nude body weight, corrected for fluid intake and urination. After the heat acclimation process the participants went through the lactate threshold and psychomotor tests in comfort conditions in two separate days similar to the pre acclimation protocol. We, thereafter, compared the differences in psychomotor and physiological responses while exposed to the hypoxic conditions before and after heat acclimation.

RESULTS

There was no change in the participants VO_2 max after heat acclimation. Maximal HR and T_{re} were significantly lower after heat acclimation compared to baseline (103 compared to 115 bpm, and 37.6 compared to 37.83, respectively; $p < 0.05$). Lactate threshold in comfort conditions was significantly higher after heat acclimation compared to baseline. We also found that lactate threshold was higher in hypoxic conditions after heat acclimation, but these results were not significant. Blood O_2 saturation during walking at a pace of 6.5 km/hr in hypoxic conditions was higher after heat acclimation compared to baseline ($88 \pm 2\%$ compared to $86.5 \pm 2\%$, respectively; $p = 0.055$).

Psychomotor performances under hypoxic conditions showed that prior heat acclimation was not associated with a significant improvement in Visual Vigilance. The Four Choice Reaction Time Test, however, showed a significant improvement after heat acclimation ($p < 0.05$). The Posture Test results during hypoxic conditions pointed to a moderate improvement ($p = 0.054$) after heat acclimation.

CONCLUSIONS

Heat acclimation reduces the physiological strain in hot and comfort climate conditions. Prior heat acclimation showed only minor influence on exercise performance and moderate influence on psychomotor performance in moderate hypoxic conditions (O_2 concentration of 15.6%). According to these results, we suggest that there is a possible cross tolerance between heat acclimation and hypoxia. A longer period of heat acclimation may be required in order to create the appropriate stimulation for complete cross tolerance response.

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