Relationship between ambient temperature and ventilatory threshold in recreationally trained collegiate males

Anne C. Mackin
Faculty Collaborator: Paul F. Mellick, Ph.D.
University of St. Thomas, St. Paul, Minnesota

Abstract

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Introduction

During exercise in hot environments, the human body has the ability to maintain sufficient cardiac output and blood pressure in order to dissipate body heat while sustaining muscle force generation (Cheuvront, 2010). As the body begins to rely not solely on aerobic metabolism, anaerobic metabolism increases and accordingly, lactic acid production increases. Lactic acidosis, in addition to an increase in carbon dioxide (CO₂) concentration in the blood (transported as bicarbonate ion), contributes to an increase in pulmonary ventilation (Poole, 1985). An individual’s ventilatory threshold (VT) depends upon their maximal volume of oxygen consumed (VO₂max). A higher VO₂max signifies aerobic training adaptations have occurred and a direct increase in aerobic performance can be seen. Therefore, anything that reduces VO₂max impairs aerobic performance (Chen, 2013). It has been established that environmental heat stress decreases an individual’s VO₂max (Cheuvront) and increases minute ventilation (Chiba, 2011). As ventilation and VO₂ increase at a faster rate, anaerobic metabolism begins to produce lactic acid earlier during exercise—inducing hyperventilation and an excessive output of CO₂ (Chiba). Consequently, the increased rate of these heat-sensitive metabolic variables decreases VT.

Since exercise activities are often performed under hot conditions, it is important to investigate the effects of the heat on different metabolic variables during exercise. I aimed to test the hypothesis that there is an inverse relationship between temperature and ventilatory threshold. Therefore, the purpose of this study was to determine the relationship between ambient temperature and ventilatory threshold in recreationally trained collegiate males.

Methods

Participants

Eight recreationally trained collegiate males volunteered to participate in the current study. Demographic information was collected from all subjects and reported in Figure 1. All of the subjects signed IRB consent (IRB #51709-1) and were instructed on the metabolic test procedure.

Procedures

A VO₂max test was performed using a treadmill with a generic ramp protocol. A TrueOne 2400 Metabolic Measurement System (Figure 4) from Par VO Medics (Model: MMS-2400, Murray, UT) was used to measure VO₂max of each subject. Heart rate was measured using a Polar heart rate monitor from Polar Electro Inc. (Woodbury, NY). After a two-minute warm up, the participant began running at their average mile pace with a 2% increase in grade every two minutes. The participant can only exceed their VO₂max as signaled by a RER > 1.15, plateau of VO₂, participant reaching their maximum heart rate or as signaled from the participant to the researcher. The participant completed a cool down no less than two minutes. This procedure was tested on two separate occasions, one at standard room temperature (22±0.5°C) and at the second at an increased room temperature (27±0.5°C). Temperature was recorded using a Davis® Vantage VueTM (Model: 6351, Hayward, CA).

Statistical Analysis

Variables were tested with a paired t-test at the 0.05 confidence level and analyzed using Minitab 16® software.

Results

Descriptive statistics presented in Figure 3 showed a significant difference (p-value < 0.05) between the mean VO₂max of the Control Trial and the mean VO₂max of the Heated Trial. Figure 3 also showed a significant difference between the mean Peak Ventilation of the Control Trial and the mean Peak Ventilation of the Heated Trial.

Conclusions

The purpose of this study was to determine the relationship between ambient temperature and ventilatory threshold in recreationally trained collegiate males. Based on the results, the hypothesis that there is an inverse relationship between temperature and ventilatory threshold can be confirmed. A statistically significant difference between the mean VO₂max and mean Peak VE values for both control and heated trials was found (p < 0.05). It was found that as temperature was increased, heat-sensitive variables that affect an individual’s ventilatory threshold (VO₂max and Peak VE) were decreased. In heated trials it was found that both variables began to increase non-linearly at a faster rate in comparison to control trials. This could be due to a lower VO₂max which could lead lactic acidosis to occur earlier during exercise. This will consequently cause higher levels of CO₂ in the blood, increasing minute ventilation.

Though a sample of eight participants was sufficient enough to detect a difference between the means of both tested variables, further studies should be done with a larger number of subjects in order to increase the validity. As the ambient temperature was only slightly increased, further studies should be performed with a larger increase in temperature.

References


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