Acute Responses to High Intensity Interval Exercise and Moderate Aerobic Exercise on Anaerobically and Aerobically Trained Athletes

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ABSTRACT

High Intensity Interval Training (HIIT) is emerging as the popular method of training recently for its ability to deliver an exercise that still elicits almost the same health benefits, when compared to traditional methods of training. Those who are trained possess higher lactate thresholds than those who are not trained. However, there is little research on males whom are trained as anaerobically or aerobically, and their differences on lactate or blood glucose recovery (3). PURPOSE: The purpose of this study is to compare the acute effects of high intensity interval exercise and moderate aerobic exercise on lactic acid and blood glucose levels on athletes who are either anaerobically trained (Ana) or aerobically (Aer) trained (1, 4). METHODS: Males (20± 2.774 yrs) of average cardiorespiratory fitness (VO_{2max} =35 ±5.95 ml·kg^{-1}·min^{-1}) participated in a high intensity interval exercise (HIIE) and a moderate aerobic trial in a balanced cross-over design in which the subject was randomized and assessed for changes in blood lactate levels and glucose levels during exercise. The HIIE is a 4 x 4 trial in which the subject pedaled on a cycle for four intervals of 4 minutes at 90-95% of maximal aerobic capacity (VO_{2max}), interspersed with 3 minutes of active recovery at 60% VO_{2max} (2). The subjects were assessed for blood lactate and blood glucose via finger stick prior to exercise, at minute 4, 13, 24, 32 and every 10 minutes post-exercise up to 30 minutes following the cessation of the exercise bout. The subjects also participated in a moderate aerobic trial (Mod) at 60% of VO_{2max}. The subjects were assessed for blood lactate and blood glucose via finger stick however time points are varied per subject due to variations in total work outputs. RESULTS: The main effect for recovery was not significant in lactate when comparing training status across both HIIE/Mod (Ana=5.7±4.3, $\boldsymbol{mmol \cdot L^{-1}}$ Aer=8.3±4.7 $\boldsymbol{mmol \cdot L^{-1}}$ (p=0.3470). The main effect for glucose was also not significant when comparing training status across both HIIE/Mod (Ana=93±12.5 $\boldsymbol{mg \cdot dL^{-1}}$, Aer=102.7±12.5 $\boldsymbol{mg \cdot dL^{-1}}$) ($p$=0.2350). The main effect for lactate when comparing training across intensity was not significant (Ana-Hi=4.6±1.2 $\boldsymbol{mmol \cdot L^{-1}}$, Ana-Mod=6.9±8.2 $\boldsymbol{mmol \cdot L^{-1}}$, Aer-Hi=5.7±1.3 $\boldsymbol{mmol \cdot L^{-1}}$, Aer-Mod=10.9±9.0 $\boldsymbol{mmol \cdot L^{-1}}$) (p=0.5620). The main effect for glucose when comparing training (Aer/Ana) across intensity (HIIE/Mod) was also not significant (Ana-Hi=93.5±20.1 $\boldsymbol{mg \cdot dL^{-1}}$, Ana-Mod=92.5±13.6 $\boldsymbol{mg \cdot dL^{-1}}$, Aer-Hi=112.8±20.1 $\boldsymbol{mg \cdot dL^{-1}}$, Aer-Mod=92.6±13.6 $\boldsymbol{mg \cdot dL^{-1}}$) ($p$=0.2100) CONCLUSIONS: Although lactate nor glucose were statistically significant in this study, when comparing the values, anaerobically trained males buffered lactic acid more efficiently than those who are aerobically trained. This might suggest that those whom are anaerobically trained possess higher lactate threshold than those who are aerobically trained.

INTRODUCTION

High Intensity Interval Training (HIIT) is emerging as the popular method of training recently for its effectiveness when compared to traditional methods of training. This popularity is mainly attributed to HIIT's training duration is half the time of traditional exercise programs. This training has become an attractive choice for those who desire to exercise regularly but experience time constraints that come with busy lifestyles. Lactate threshold is often utilized as a bench mark for performance capacity as it indicates endurance. Those are who are trained possess higher lactate thresholds than those who are not trained. However, there is little research on males whom are trained as anaerobically or aerobically, and their differences on lactate acid or blood glucose recovery.

PURPOSE

The purpose of this study is to compare the acute effects of high intensity interval exercise and moderate aerobic exercise on lactic acid and blood glucose levels on athletes who are either anaerobically trained or aerobically trained.

METHODS

IRB Approval. The study was approved by the Institutional Review Board (Human Subjects) at Texas A&M University-Kingsville.

Subjects. All subjects were provided informed consent prior to testing. Twelve male subjects (N=12) were recruited from the student population at Texas A&M University-Kingsville.

Pre-participation Screening/Testing. All subjects underwent a health screening in accordance with the American College of Sports Medicine's guidelines for exercise testing and prescription. Only subjects classified as low risk for untoward events during exercise based on these guidelines were allowed to participate. Tests for body composition (mass, stature, percent body fat from skinfolds) and peak oxygen consumption (via open circuit spirometry, Astrand cycle protocol) were also conducted. Subjects were given instructions on how to report for each experimental trial.

Experimental Design. All participants underwent a high intensity interval exercise (HIIE) and a moderate aerobic trial in a balanced cross-over design in which the subject was randomized and assessed for changes in blood lactate levels and glucose levels during exercise.

METHODS, cont.

Treatments. The HIIE is a 4 x 4 trial in which the subject pedaled on a cycle for four intervals of 4 minutes at 90-95% of maximal aerobic capacity (VO2max/peak), interspersed with 3 minutes of active recovery at 60% VO2max/peak. The subjects were assessed for blood lactate and blood glucose via finger stick prior to exercise, at minute 4, 13, 24, 32 and every 10 minutes post-exercise up to 30 minutes following the cessation of the exercise bout.

The subjects also participated in a moderate aerobic trial at 60% of VO2max/peak. The subjects were assessed for blood lactate and blood glucose via finger stick prior to exercise, at 25%, 50%, 75% and 100% of total work output. These time points are varied per subject due to variations in total work outputs. All subject underwent complete warm-up and cool-down periods in which they will pedal on a cycle for 5 minutes with no resistance on the flywheel at a rate of 50 revolutions per minute (rpm). The subjects were assessed for blood lactate every 10 minutes for a duration of 30 minutes post exercise as well.

Measurements. During each experimental trial, the following measurements were made:

Blood Lactate ($\boldsymbol{mmol \cdot L^{-1}}$) - Subjects were assessed pre-exercise, at 25%, 50%, 75%, 100%, and post exercise for 30 minutes every 10 minutes.

Blood Glucose ($\boldsymbol{mg \cdot dL^{-1}}$) - Subjects were assessed pre-exercise, at 25%, 50%, 75%, 100%, and post exercise for 30 minutes every 10 minutes.

Statistical Analysis. Two-way (training x exercise intensity) ANOVA with repeated measures was used to analyze for differences between subject training status (Ana, Aer) and within exercise intensity (HIIE, Mod) in blood lactate and blood glucose. If needed, appropriate *post hoc* tests were used to make all pairwise comparisons for specific differences between the training groups and/or across exercise intensities. The experimentwise error rate (α=0.05) was maintained throughout all *post hoc* tests for specific differences.

RESULTS

Table 1: Subject Demographics

Variable	Mean	SD	Range
Age (yr)	20.7	2.7	18-28
Body Mass (kg)	87.4	18.6	63-125
Body Stature (in)	70.1	2.1	66-73.5
Body Fat (%)	16.8	6.5	7-26.8
VO2max (ml · kg^{-1} · min^{-1})	35.7	5.9	27-44.2

The main effect for recovery was not significant in lactate when comparing training status across both conditions (Ana=5.7±4.3 $\boldsymbol{mmol \cdot L^{-1}}$Aer=8.3±4.7 $\boldsymbol{mmol \cdot L^{-1}}$) ($p$=0.3470). The main effect for glucose was also not significant when comparing training status across both conditions (Ana=93±12.5 $\boldsymbol{mg \cdot dL^{-1}}$, Aer=102.7±12.5 $\boldsymbol{mg \cdot dL^{-1}}$) ($p$=0.2350). The main effect for lactate when comparing training (Aer/Ana) across intensity (HIIE/Mod) was not significant (Ana-HIIE=4.6±1.2 $\boldsymbol{mmol \cdot L^{-1}}$, Ana-Mod=6.9±8.2 $\boldsymbol{mmol \cdot L^{-1}}$, Aer-HIIE=5.7±1.3 $\boldsymbol{mmol \cdot L^{-1}}$, Aer-Mod=10.9±9.0 $\boldsymbol{mmol \cdot L^{-1}}$) ($p$=0.5620). The main effect for glucose when comparing training across intensity was also not significant (Ana-HIIE=93.5±20.1 $\boldsymbol{mg \cdot dL^{-1}}$, Ana-Mod=92.5±13.6 $\boldsymbol{mg \cdot dL^{-1}}$, Aer-HIIE=112.8±20.1 $\boldsymbol{mg \cdot dL^{-1}}$, Aer-Mod=92.6±13.6 $\boldsymbol{mg \cdot dL^{-1}}$) ($p$=0.2100)

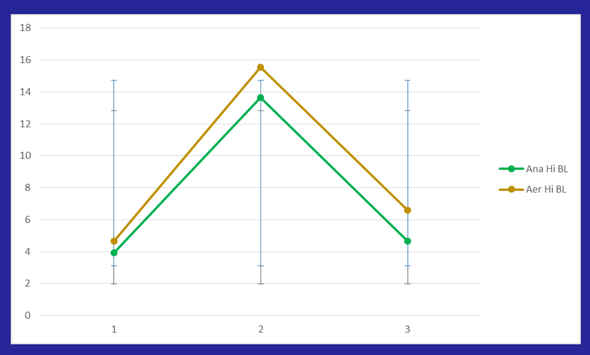

Figure 1: Anaerobic and aerobic blood lactate *($\boldsymbol{mmol \cdot L^{-1}}$)* responses to high intensity interval exercise. Although not statistically significant, anaerobically trained males had a lower blood lactate response, when evaluation pre, post and recovery. (p=0.5620)

RESULTS, cont.

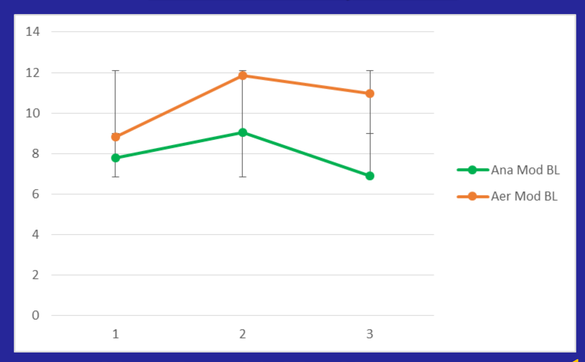

Figure 2: Anaerobic and aerobic blood lactate *($\boldsymbol{mmol \cdot L^{-1}}$)* responses to moderate aerobic exercise. Although this was not statistically significant, anaerobically trained males had a lower blood lactate response. This is consistent with findings when comparing high intensity interval exercise. (p=0.5620)

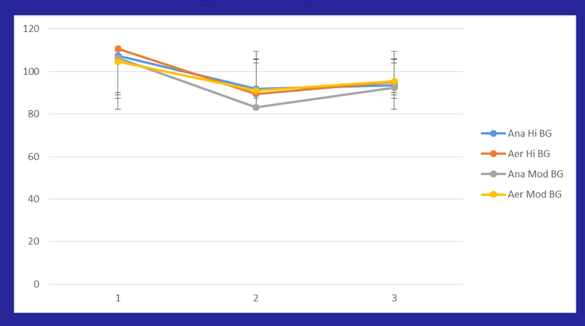

Figure 3: Anaerobic and aerobic blood glucose *($\boldsymbol{mg \cdot dL^{-1}}$)* responses to high intensity interval exercise and moderate aerobic exercise. There were no statistically significant differences in blood glucose response to H.I.I.E and moderate aerobic exercise. This indicates that training status has no effect upon blood glucose response during exercise. (p=0.2100)

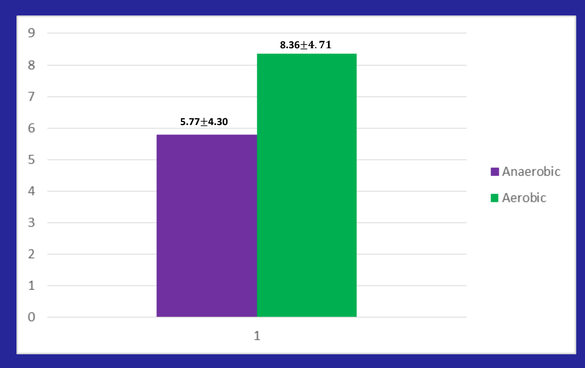

Figure 4: Effect of training status on blood lactate *($\boldsymbol{mmol \cdot L^{-1}}$)* recovery when combining both exercises. Although it was not statistically significant, anaerobic trained males had lower blood lactate responses after recovery. (p=0.3470)

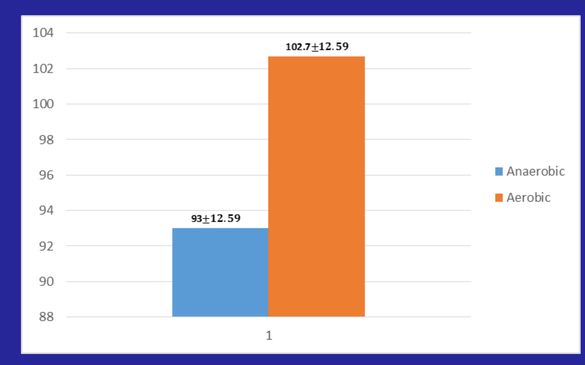

Figure 5: Effect of training status on blood glucose *($\boldsymbol{mg \cdot dL^{-1}}$)* recovery when combining both exercises. There were no statistically significant difference between the training groups when comparing blood glucose after recovery period. (p= 0.2350)

CONCLUSIONS

Although lactate and glucose were not statistically significant in this study, when comparing the values, anaerobically trained males buffered lactic acid more efficiently post-exercise than those who are aerobically trained. This might suggest that individuals who are anaerobically trained possess higher lactate threshold than those who are aerobically trained. Perhaps, if a larger sample size was utilized then the results would have been statistically significant when comparing anaerobic and aerobically trained males. Regardless, the information from this study is useful when implementing HIIT training protocols for trained individuals by eliminating the need to alter the protocol based on training status in relation to the association of fatigue with lactic acid.

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