The Relationship Between RPE and Blood Lactate Concentrations During a VO_2 Max Test On a Cycle Ergometer

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Abstract

INTRODUCTION: Lactate (La) is produced by the body's muscles in response to exercise through anaerobic glycolysis. During exercise, most of the lactate produced enters the heart and slow twitch muscle fibers by traveling within the blood throughout the body. The lactate diffused into the blood is referred to as blood lactate. Blood lactate (BLa) is used as a measurement of exercise intensity since there is a strong relationship between the two. With increasing blood lactate and intensity there is also an increase in exertion. This exertion during exercise is measured through the rate of perceived exertion scale (RPE). The Borg RPE scale in particular is a range between 6-20 with it ranging from very, very light to very, very hard. During exertion the heart starts to increase it's beating in order to distribute blood throughout the body to meet the demands of stress placed upon it. Heart rate (HR) is based off the number of contractions of the ventricles within a unit of time. In addition, Maximal Oxygen consumption (VO_2 Max) is another factor that increases with the previous variables mentioned. Maximal oxygen consumption is the maximal rate of oxygen consumed during incremental exercise and reflects the aerobic fitness level of an individual.

PURPOSE: The purpose of this study was to determine the relationship between RPE and blood lactate concentrations during a maximal test on a cycle ergometer.

METHODS: Two female (W; age 23.5 ± 2.12 yrs.) and seven male (M; age 22.9 ± 1.77 yrs.) UTA students participated in this study. Each subject was tested to maximal demands on a cycle ergometer along with a metabolic cart in order to measure VO_2 max. During the maximal staged test the workload increased for both males and females. A Lactate Plus Meter measured the blood lactate produced by each individual though finger pricking during resting, every third minute throughout the test and after cool down. Blood lactate (BLa), RPE, heart rate (HR), and maximal oxygen consumption (VO_2 Max) were all recorded and used for this study.

RESULTS: The average and standard deviation at each stage for all subjects are as followed. HR (beats·min $^{-1}$);BLa (mmol·L^{-1});VO_2 (ml·kg^{-1}·min^{-1}). Stage 1: HR 112 ± 9.54, bLa 5.01 ± 3.61, RPE 6.44 ± 0.53, VO_2 7.86 ± 3.96, r^2 0.29. Stage 2: HR 117 ± 12.01, bLa 4.21 ± 2.14, RPE 7 ± 1.12, VO_2 12.9 ± 3.15, r^2: -.024. Stage 3: HR 135 ± 15.69, bLa 6.34 ± 4.34, RPE 10.1 ± 2.85, VO_2 16.59 ± 3.27, r^2: -0.49. Stage 4: HR 138 ± 53.79, bLa 8.76 ± 4.21, RPE 12.67 ± 3.04, VO_2 20.96 ± 4.66, r^2: 0.11. Stage 5: HR 171 ± 26.89, bLa 12.09 ± 5.96, RPE 15.38 ± 3.25, VO_2 28.44 ± 5.02 r^2: 0.53. Stage 6: HR 168 ± 24.28, bLa 8.38 ± 2.96, RPE 16.25 ± 2.99, VO_2 29.63 ± 5.0, r^2: 0.77. Stage 7: HR 169 ± 22.52, bLa 10.07 ± 4.14, RPE 17.67 ± 1.15, VO_2 33.3 ± 2.96, r^2: 0.93. Stage 8: HR 176 ± 7.78, bLa 9.6 ± 0.28, RPE 18.5 ± 0.71, VO_2 35.55 ± 1.2, r^2: -1. With each progressing stage, the relationship between RPE and bLa increased.

CONCLUSION: The results of this study suggest that there is a relationship between RPE and blood lactate. As RPE increases with each stage, the relationship between RPE and blood lactate increases.

Purpose

The purpose of this study was to determine the relationship between RPE and blood lactate concentrations during a maximal test on a cycle ergometer.

Methods

Subjects

For this study, 9 subjects participated in a cycle ergometer maximal test. 7 males and 2 females voluntarily participated in this study. The subjects were mostly UTA students, one was not a student. The age for males ranged from 21-26, while females were 22 and 25. For males, Asians constituted 57%, African Americans 29%, and Caucasians 14%. Hispanics constituted 100% for females.

Instrumentation

Rate of perceived exertion score (RPE) was taken using a Borg RPE scale with ratings from 6 (rest) to 20 (maximal exercise). Heart rate was measured using a heart rate monitor that was attached to the subject's chest. It was synced to a watch that digitally displayed the subject's real time heart rate. The Lactate Plus Meter was used to analyze the sample of blood from the subject's finger after pricking it with a lancet. A test strip was inserted into the Lactate Plus Meter and collected the subject's blood sample. After waiting 15 seconds the meter showed the subject's blood lactate concentration. All of this was performed while the subject was on a cycle ergometer connected to a metabolic cart which calculated VO_2 Max.

Methods (cont'd)

Protocol

A maximal exercise test on a cycle ergometer was performed. Informed consent forms were signed and turned in before or at the beginning of the lab. Upon arriving at the lab, a heart rate monitor was attached to the subjects chest to allow measurement of heart rate. This signal was sent to a watch where the heart rate was shown. The age, height, and weight was recorded on the data sheet and then inputted into the PARVO TrueOne program. The cycle ergometer seat height and hand rail was adjusted to the subjects preference. Once the subject sat on the cycle ergometer, the headgear was fitted to their head in order to hold the mouthpiece in place. Oxygen consumption was collected using the PARVO metabolic cart during the exercise. Resting values of heart rate and blood lactate were recorded prior to the exercise test. The subject maintained a cadence of at least 60 RPM. Each staged consisted of three minutes. After the subjects had completed their one minute warm up, the cycle ergometer protocol increased resistance by 25W for females and 50W for males every three minutes until max was reached. RPE, HR, Bla, and VO_2 Max values were taken during the last minute of each workload. The Lactate Plus Meter analyzed the sample to find lactate level. They were given a gauze to stem the bleeding and a band aid as necessary. All equipment used was disposed of in the proper biohazard waste containers. This measurement was repeated at rest, the last minute of each stage, at maximal exertion, and the end of recovery. The cycle ergometer was sent into recovery mode for a 5 minute cool down once the subject could no longer continue or maintain 60 rpms.

Statistical Analysis

On Microsoft Excel, all of the subject's values were computed at every stage. Correlations between all subjects at each stage were then compared.

Variable	Mean	SD
Age	23	±1.66
Height (m)	1.72	±0.12
Weight (kg)	77	±17.97
BMI	25.61	±3.54

Results

Variables	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8
HR (beats·min $^{-1}$)	112 ± 9.54	117 ± 12.01	135 ± 15.69	138 ± 53.79	171 ± 26.89	168 ± 24.28	169 ± 22.52	176 ± 7.78
bLa (mmol·L^{-1})	5.01 ± 3.61	4.21 ± 2.14	6.34 ± 4.34	8.76 ± 4.21	12.09 ± 5.96	8.38 ± 2.96	10.07 ± 4.14	9.6 ± 0.28
RPE	6.44 ± 0.53	7 ± 1.12	10.1 ± 2.85	12.67 ± 3.04	15.38 ± 3.25	16.25 ± 2.99	17.67 ± 1.15	18.5 ± 0.71
VO_2 (ml·kg^{-1}·min^{-1})	7.86 ± 3.96	12.9 ± 3.15	16.59 ± 3.27	20.96 ± 4.66	28.44 ± 5.02	29.63 ± 5.0	33.3 ± 2.96	35.55 ± 1.2

Using Microsoft Excel, the correlation was calculated at each stage using RPE and blood lactate results between all subjects. After doing so, the correlation between the variables was determined. As workload increased, the relationship between RPE and blood lactate also increased.

Correlation	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8
r^2	0.29	-0.24	-0.49	0.11	0.53	0.77	0.93	-1

Conclusions

The results of this study suggest that there is a relationship between RPE and blood lactate. As RPE increases with each stage, the relationship between RPE and blood lactate increases and was the highest at the last two workloads of the cycle ergometer test.