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Analysis of blood lactate and heart rate of indoor sports athletes as a response to various loads

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Abstract

The aim of this study is to analyse the changes in blood lactate and heart rate levels of indoor sports athletes as a response to various loads in cycle ergometer. The participants of the study are 28 male volunteer athletes of indoor sports active in basketball, volleyball, handball league. Age: 21.00 ±1.56 years, height: 181.54 ± 7.67 cm, weight: 83.04 ± 10.69 kg. Heart rate and lactate measurements of the subjects were taken from their fingertips at rest and following every load increase. With the initial load of 1 kg, the subjects were exposed to 0.5 kg load increase every three minutes. Since only 3 subjects completed with the final load of 4.5 kg, the values of this load was excluded. Pearson multiplications Moment Correlation was used to determine the relation between the load increase of the groups and their heart rate and between the load increase of the groups and their blood lactate values. The test results revealed a significant relation between the load means applied on the subjects and their heart rate at the rate of -0.99; between the applied load means and blood lactate at the rate of 0.97.

Keywords: Indoor sports, lactate, heart rate.

INTRODUCTION

During exercise, changes in heart rate (HR) and heart beat volume are adjusted according to the increasing metabolic need of the body. Heart rate is determined by the heart beat number per minute. Heart rate is the number of vibration in the artery wall caused by the systolic shoot of blood per minute (11). While HR is high in children and teenagers during rest, it is lower in adults and athletes especially with high performance thanks to the formation of new capillaries and economic use of oxygen. While it is between 60 and 80 during rest, HR can rise up to about 200 with exercise and can be returned to normal within 1-2 hours (26). Maintaining the balance of heart rate and heart beat volume that rise as a response to the increasing energy need is crucial for an individual to sustain the task (25). Two most important parameters used by trainers and sports scientists to assess aerobic strength are (HR) and blood lactate (LA) responses to submaximal exercise forces (15). Lactate exists between 5-10 mg or 0.5-1mmol/L values in 100cc blood under normal conditions (8). Lactic acid level of trained individuals during rest is 0.5–2.2 mmol/L (≅ 4.5–19.8 mg/dl) (13).

Lactate is the only metabolic parameter showing the skill of muscles for athletic performance. The skill of muscles means the ability of muscles to achieve maximum performance during a sports activity for maintaining harmonious and balanced energy required by the activity. For this purpose, the athlete generates the top amount for each energy per time throughout the activity. Anaerobic threshold defines the metabolic change region where the rise in anaerobic energy production starts when the increasing metabolic need of the body during exercise cannot be met by aerobic energy systems. It has been shown that arterial blood lactate concentration starts to rise above the rested level in this change region where anaerobic metabolism is added to aerobic metabolism during exercise (29).

The rise in lactic acid (LA) continues during short time maximal force exercises during which oxygen is not sufficient. It is known that high blood lactate is a limiting factor during exercise. Also, the rise in lactic acid prevents muscle contraction and so accelerates fatigue (16). The most efficient method in determining anaerobic threshold is measurement of lactate concentration in artery blood periodically during exercise (30). Continuous or intermittent test protocols in vitro on the treadmill with increasing force are widespread as a test uncharacteristic to sports to determine aerobic strength (4).

The time for reaching the top lactate level might show discrepancies among individuals depending on the exercise time, exercise force, how trained the individuals are and their performance in the test (10). The frequency of doing high force exercise and the duration of the exercise are among the factors determining lactic acid amount produced in the muscle anaerobically, the other factors being age and gender, genetic characteristics, muscle structure and muscle cross-sectional area, fibril composition, training content and training age (6). In individuals lacking fitness, compared to trained ones, lactic acid increase is more as response to spending the same effort (27). As the force of the exercise rises and when more energy is required to sustain the performance, aerobic metabolism struggles to break down the resultant pyruvate with oxygen. The only way to get the required energy is by incorporating anaerobic metabolism into energy production and turning the resultant pyruvate into lactate form. However, muscles can work for a certain amount of time before their cell function and metabolism change due to lactic acid penetration into the cell. If the exercise force decreases, aerobic energy system gets the capability of breaking down more energy resource with oxygen and thus the resultant lactate is used to produce energy by turning it again into pyruvate. If the exercise force continues at high level, lactate passes from muscle to blood and is delivered to liver, heart, skeleton muscles and the other organs and tissues to be used as a source of energy (18). Because during exercise LA concentration is affected by various factors like diet, muscle glycogen store, dehydration, the place where the blood is taken (arterial or venous), exercise type, blood process type (whole blood, plasma), how the blood samples are stored and storage time, analyser and testing place (laboratory or field), running speed and HR. values determined depending on LA for specific endurance trainings may also change depending on these factors (17,23). The aim of this study is to determine the blood lactate and heart rate responses of indoor sports athletes to different loads.

MATERIAL & METHOD

Twenty eight male athletes age: 21,00 ±1,56 years, height: 181,54 ± 7,67 cm, weight: 83,04±10,69 kg, involved in indoor sports like basketball, volleyball, handball in senior league participated in the study voluntarily. Prior to the test, the subjects were informed about the test.

Different loads of the subjects were measured using Monark bike ergometer (Monark 894E, Peak Bike, Sweden), their heart rates were measured using polar watch (Polar RS800CX) and their blood lactate levels were measured using CARE Diagnostica Ecotwenty device.

Bike pedal speed of each subject was constant between 60 and 70 watt. The starting load was 1 kg, the subjects were loaded 0.5 kg extra load every 3 minutes until exhaustion. Blood lactate measurements of the subjects were taken from their fingertips prior to the test and following each load increase. Their heart rates were also recorded prior to the test and following each load increase. Their heart rates were measured using polar heart rate monitor (Polar RS800CX) and their blood lactate levels were measured using CARE Diagnostica Ecotwenty device. The blood lactate measurements of the subjects were conducted in 10 seconds during rest and prior to each load increase, but their heart rates were recorded following each load increase. No rest interval was given either prior to or following each load increase.

Statistical Analysis

The relation between load increase and blood lactate and heart rate was analysed with Pearson product-moment correlation at p=0.05 significance level. Data analyses were conducted using SPSS 15.0 statistical program.

RESULTS

Table 1 shows the descriptive statistics of the subjects. Their age average is 21.00 ± 1.56 years and their height average is181.54 ± 7.67 cm, while their weight average is 83.04 ± 10.69 kg. Table 2 shows the rested blood lactate values of the subjects and their blood lactate values after load increase.

Table 1. Descriptive statistics of the subjects.

Variables	Mean	SD
Age(year)	21,00	1,56
Height (cm)	181,54	7,67
Body Weight (kg)	83,04	10,69

Table 2. Blood lactate values in rest and after load increase (mmol/L).		
Variables	Mean	SD
Rested Blood lactate	2,29	0,93
Blood lactate after 1 kg load	3,01	1,27
Blood lactate after 1,5 kg load	3,40	1,32
Blood lactate after 2 kg load	3,80	0,97
Blood lactate after 2,5 kg load	5,22	2,01
Blood lactate after 3 kg load	7,31	2,64
Blood lactate after 3,5 kg load	8,84	2,51
Blood lactate after 4 kg load	9,04	1,91
Blood lactate after 4,5 kg load	10,43	1,21

Table 3. Hear rate values in rest and after load increase (Beat/min).		
Variables	Mean	SD
Rested heart rate	78,25	8,73
Heart rate after 1 kg load	111,25	6,70
Heart rate after 1,5 kg load	125,25	14,38
Heart rate after 2 kg load	137,25	13,40
Heart rate after 2,5 kg load	151,50	13,96
Heart rate after 3 kg load	166,00	16,02
Heart rate after 3,5 kg load	183,50	10,75
Heart rate after 4 kg load	188,03	6,96
Heart rate after 4,5 kg load	194,33	5,03

Table 3 shows the rested heart rate values of the subjects and their heart rate values after load increase.

As a result of Pearson product-moment correlation analysis, a significant relation was found between load increase and blood glucose values of the subjects ($r=-0.86$; $p<0.05$), between load increase and blood lactate values of the subjects($r=0.97$; $p<0.05$), and between load increase and heart rate values of the subjects ($r=0.99$; $p<0.05$).

DISCUSSION

In indoor sports, the performance of the athletes is generally determined by the game time and game pace. As a result, training programs aim to retard the fatigue formation time and to improve endurance against fatigue. Blood lactate profile is an important tool in determining the endurance capacity and maintaining the training control (9). 14 males, age 22±3 years, height 177±7 cm, weight 71±6 kg, participated into a study of Aslankeser et al. (1), voluntarily and the participants were exposed to sprint runs whose force was increased gradually for 5 weeks (3 day/week). As a result, they found that endurance against fatigue improved statistically significantly ($p<0.05$). Besides an extension in exhaustion time, blood lactate levels also increased after training (1). The physiological variables obtained from increasing load exercise tests are generally used in predicting long-term exercise force (5,12,14,19). The physiological responses at individual level seem to vary as the exercise force increases. These findings are consistent with the results of other studies with similar forces (20,21,22). As a rule, heart rate (HR), strength outcome, speed, the used percentage of VO_2 max (%$VO_{2\,max}$), [La] and respiratory parameters are used in controlling the exercise force (7). Magnoni et al. (19) stated that HR and VO increase with the rise of body heat and, for these two reasons, when exercise is done ate load corresponding to the HR obtained at increasing load exercise test, they don't correspond to the calculated HR. Also, in the studies conducted at such a force corresponding to the determined [La] value, as the activity proceeds, metabolic values rise as a response to the constant force and a metabolic threshold occurs as a response to a different force (28). Atalay Guzel et al. (2), in one of their studies on the changes in blood glucose, lactate and creatine kinase levels of elite beach handball players, found that serum lactate concentrations increased from 4.07±0.6 mmol/L to 6.05±1.3, which was found to be statistically significant. This expected increase is consistent with the literature and can be explained with anaerobic characteristics of sports (2).

In a study of Sentürk (24), glucose blood parameter value of both male and female handball players were found higher before the game (102.55 ± 1.641 mg/dl) than after the game (92.6 ± 1.545 mg/dl), which shows that the game was a factor on glucose blood parameter.

According to the results of this study, it was determined that a game is a factor on glucose blood parameter. Compared to prior to the game, glucose blood parameter value decreased after the game. This result is consistent with the previous studies (24).

Baltaci et al. (3) studied the effect of VO_2-directly determined on spiro ergometer and predicted- on lactate in their study on trained athletes of ages 14-18 years. High correlation was observed between VO_2 maxand lactate concentration on bike and treadmill (for bike r=.99, for treadmill r=.97). Also, highly significant relation was found between loading as watt or km/hour and lactate concentration (for bike r=.98, for treadmill r=.99). The study of Baltaci et al. (3) is parallel with ours.

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