



Blood lactate level in Elite boy swimmers after lactate tolerance exercise test

**Asghar Nikseresht¹, Iman Yabande², Karamatollah Rahmanian^{2,*},
Abdolreza Sotoodeh Jahromi³**

¹Department of Sport Physiology, Islamic Azad University, Jahrom Branch, Jahrom, Iran

²Research Center for Social Determinants of Health, Jahrom University of Medical Sciences, Jahrom, Iran

³Research Center for Non-Communicable Diseases, Jahrom University of Medical Sciences, Jahrom, Iran

***For correspondence:**

rahmaniank47@yahoo.com

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Abstract

Introduction: To avoid injuries during high-intensity sports training, it is important to recognize conditions of bodily consumption and production of adequate energy; exercise increases the concentration of the blood lactate. This paper is an attempt to compare pre and post lactate tolerance exercise test - blood lactate concentrations - of elite boy swimmers. **Methods:** Blood lactates are measured by an enzymatic method on 12 subjects 30 minutes before and adjust and 24 hours after the test. **Results:** The mean lactate concentration of 30.35 ± 12.16 mg/dl is observed in swimmers 30 minutes before the test. Swimmers adjust after the test show mean blood lactate concentration of 108.52 ± 18.17 mg/dl that is significantly higher than 30 minutes before the test ($p < 0.001$). Then blood lactate level decreases below baseline level at 24 hours after the test. **Conclusion:** Blood lactate increases with the test and decreases below baseline within 24 hours after the test.

Keywords

Lactate Tolerance Test, Swimmer, Blood lactate, Male

Introduction

During high-intensity sports training, it is important to recognize in what conditions the body consumes and produces adequate energy to avoid injuries. Exercise increases the concentration of the blood lactate. Additionally, blood lactate is related to intensity (Rogatzki et al., 2014; Vescovi et al., 2011) and distance of exercise (Keskinen et al., 2007; Vescovi et al., 2011). Issurin et al (Issurin et al., 2001) has found that the highest level of lactate concentrations is formed during butterfly swimming, followed by other styles including breaststroke, backstroke and freestyle swimming indicated by three different tests with 22 highly trained swimmers (14 male, 8 females) as subjects. The blood lactate significantly increased with the gradually enhanced achievement (LI, 2010). Conversely, Halfslder et al reported that the mean blood lactate concentration decreased in longer distance of swimming (Holfelder et al., 2013). In another study conducted by Sawka et al (Sawka et al., 1979), swimmers in the 200-yd butterfly, back, breast and freestyle races had similar mean blood lactate concentrations (ranging from 16.4-20.6 mm/l).

Blood lactate level was significantly increased immediately after 3 exercises and returned to the basic level within the next 3 hours (Zaree and Yarahmadi, 2013). The results showed that the plasma lactate concentration increased immediately after the exercise in comparison to former results - 24 hours after exercise - at all levels of intensity (Sholi et al., 2015). Rogatzki et al reported that blood ammonium and lactate seemed to accumulate in response to an increasing number of repetitions with decreasing rest time between sets (Rogatzki et al., 2014). Bonifazi et al showed that the post-competition blood lactate concentrations were higher in the main competitions than in the preparatory competitions (Bonifazi et al., 2000). Altimari (Altimari et al., 2010) suggested that increasing the swimming distance significantly decreased the mean speed ($p < 0.01$). The mean blood lactate concentration 7 min after the induction of acidosis during the lactate minimum test was 10.79 ± 1.65 mm/l (Altimari et al., 2010). Gorostiaga et al (Gorostiaga et al., 2014) used leg press exercise to examine blood lactate and ammonia and muscle lactate. Thirteen men participated and 1 repetition maximum leg press strength 199 ± 33 kg performed either 5 sets of 10 repetitions to failure (5×10 RF), or 10 sets of 5 repetitions not to failure (10×5 RNF) with the same initial load (10RM) and inter-set rests (2 minutes) on 2 separate sessions in random order. The 5×10 RF resulted in significant high levels of muscle lactate (25.0 ± 8.1 mmol/kg wet weight), blood lactate (10.3 ± 2.6 mmol/L), and blood ammonia (91.6 ± 40.5 μ mol/L). During 10×5 RNF no or minimal changes were observed (Gorostiaga et al., 2014).

Lactic acid was not a waste material after anaerobic exercise, on the other hand it was such a vital, energetic substrate for oxidization (Hashimoto and Brooks, 2008). Thus, a high glycolytic capacity might mean that a player could produce more lactate to perform high-intensity exercise and could use the lactate for

oxidation by continuing to exercise at a high level of intensity. Muscle cells had 2 major functions including the production and clearance of lactate, and blood lactate levels changed as a result of a balance between production and clearance.

Blood lactate measurement was a classical method for many decades (Beneke et al., 2011; Devlin et al., 2014). Generally, blood lactate was increased with exercise intensity (Aguiar et al., 2015; Benelli et al., 2007) which showed a clear transition from aerobic activity to anaerobic activity (Aguiar et al., 2015). In details, blood lactate was increased slowly at the beginning and then elicited an exponential rise during graded incremental exercise. For now, lactate accumulated as it was produced much faster than its decomposition. Baron et al in a 2 hour swimming test showed that capillary lactate concentration decreased significantly between 10th to 20th minute after the test (Baron et al., 2005).

The aim of present study was to compare blood lactate thirty minutes before and just and twenty-four hours after the lactate tolerance exercise test.

Materials - Methods

Twelve male swimmers who were members of the Fars Province team with at least 5-10 years of experience, agreed to participate in this study. They were between 14 and 18 years old. Swimmers were informed about the experimental procedure and of the potential risks and benefits of the study. Swimming players signed written consent for participation. The present study was approved by the Human Ethics Committee of the Jahrom University of Medical Sciences (JUMS.REC.1393.016).

After a resting of 24 hours, a self-selected warm-up swim was done. Then swimmers performed Lactate Tolerance Exercise Test (LTET) which included an 800 m swim with higher than threshold intensity during eight times using a normal diving start at 1-min intervals. The test was performed in a 50-m indoor pool.

Blood samples were collected from the subjects 3 times in total; that is, 30 minutes before and just and 24 hours after trial set. Blood lactate levels were analyzed by ELIZA and auto-analyzer instrument.

The Kolmogorov–Smirnov test was applied for testing each variable's normality. To compare the study variables (blood lactate before and after LTET), we used Pair t test to compare blood lactate before test with adjust and with 24 hours after the test. Mean and SD values were obtained for all descriptive variables. A p value of <0.05 was considered significant.

Results

According to **Table 1**, the analysis showed that there was a significant difference between blood lactate 30 minutes and just after the LTET ($p \leq 0.001$) and between adjust and 24 hours after the LTET ($p \leq 0.001$). Blood lactate concentration decreased after interruption of the test and approximately returned to below the baseline level at 24 hours after the test.

Table 1. Blood Lactate concentration before and after Lactate Tolerance Swimming Test in elite boy swimmers

	30 minutes before competition		Just after competition		24 hour after competition	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Blood lactate (mg/dl)	30.35	12.16	108.52	18.17	26.51	8.57

Table 2. Blood Lactate levels (mg/dl) in individual boy elite swimmers

Record	30 minutes before lactate tolerance exercise test (1)	Just after lactate tolerance exercise test (2)	24 hour after lactate tolerance exercise test (3)	Different between (1) and (2)
1	26.44	136.63	24.85	110.19
2	18.91	98.61	24.00	79.70
3	32.9	86.88	21.20	53.98
4	15.53	97.12	24.55	81.59
5	35.44	128.53	23.05	93.09
6	40.08	84.99	44.05	44.91
7	26.43	109.19	19.15	82.76
8	62.64	108.70	41.07	46.06
9	27.06	88.90	18.75	61.84
10	27.90	106.14	24.66	78.24
11	23.15	125.35	18.78	102.20
12	27.72	131.24	34.05	103.52

The highest blood lactate levels were observed in swimmer number 8 and the lowest in swimmer number 4 who participated 30 minutes before lactate tolerance test (**Table 2**). Just after the test, the swimmer number 1 had the highest and number 3 showed the lowest blood lactate level. The swimmer number 8 and 11 had respectively the highest and the lowest blood lactate level at 24 hours after the test. The maximum different blood lactate level was observed for swimmer number 1 in the span of time of before and just after the test. On the contrary, the athlete number 6 had lowermost blood lactate different.

Discussion

During sports activities and physical exercise, sequences of physiological and biochemical changes happen, which reflect the stress of body under the load of training. For coaches and athletes, determining the load and duration of training has been scientifically a difficult problem for many years. When the training load and duration is larger than athletic abilities, it always causes injuries for athletes. On the contrary, too small loads fail to improve sports abilities and level effectively.

The production of lactate is believed to be augmented during exercise. This substrate diffuses from the muscle and accumulates in the blood. If the blood lactate is measured, it can serve as an indicator of activated processes during a workout. In light to moderate practices, the accumulation of lactate in the blood does not exist or is low. As the workload increases, blood lactate is also increased. However, blood PH is decreased when the level of lactate in muscles and blood goes up. Increment of blood PH may interfere with enzymatic activity of several glycolytic enzymes and actin-myosin interaction with the contractile process that may serve as a limiting function in exercises. Lactate has often used as an indicator of the intensity of exercise as well as the recovery from it.

We found that blood lactate level was significantly increased during LTET test. This result was similar to previous studies. Ikeda suggested that the twelve swims rushes with approximately 1 minute interval induced a significant increase in serum lactate (Ikeda, 2002). Mean blood lactate levels rose suddenly from an initial level of 1.34 ± 0.35 mm before the first set to 12.28 ± 1.55 mm after the first set. Then, lactate levels fell before rising again after the sets. Takagi et al suggested that the highest blood lactate levels were observed after the first trial set, they decreased significantly toward the second trial set, and were maintained at the same level after the third trial set (Takagi et al., 2013). Also, Kantanista et al (Kantanista et al., 2016) found that exercise increases blood lactate.

Contrary to our results, Melchorrim et al reported that mean blood lactate level was 7.7 ± 1.0 mm, and that blood lactate levels were 7.7 ± 1.2 , 7.8 ± 0.6 , 7.5 ± 0.9 ,

and 7.2 ± 1.6 mm during the first, second, third, and fourth quarters, respectively (Melchiorri et al., 2010). Also, Vicente et al suggested that lactate concentration remained stable during half squat exercise at the lactate threshold among 13 healthy subjects (Garnacho-Castaño et al., 2015).

In our study the concentration of lactate in the blood achieved its below resting value after 24 hours of recovery. This data was in line with the findings of Degoutte et al (Degoutte et al., 2003), who observed that lactate concentrations in blood were appeared to return to the baseline level within 24 hours. Also, in study conducted by Kantanista blood lactate decreased after the interruption of exercise (Kantanista et al., 2016). Adversely, Jafari et al suggested that the blood lactate significantly increased 24 hours after 1600 meter running among 27 non athlete boys (Jafari et al., 2016). Other research (Ament et al., 1999) indicated that lactate still elevated after 30 minutes of recovery in healthy volunteers.

The investigators suggested a positive correlation between lactate production and average speed or distance of exercise (Avlonitou, 1996). Also, Benelli et al in 52 male swimmers aged 40-79 years suggested that the blood lactate is dependent to the intensity and distance of competition (Benelli et al., 2007). They stated that peaks of lactate were observed in distance of 100 m. Also, Kantanista reported that by increasing the speed of the treadmill, blood lactate was increased (Kantanista et al., 2016).

Diet and nutritional status may stimuli strength and power adaptation (Crewther et al., 2006; Duke et al., 2011). Short-term diet modification has Influence on the blood lactate to rating of perceived exertion (Arshadi et al., 2017). The effect of sleep and sleep deprivation on cortisol and testosterone responses, anaerobic performance indices and blood lactate have been approved in active men (Sholi et al., 2015). We didn't evaluate these factors in present study. This can be seen as a limitation of our study. But blood sampling was drawn for participants 30 minutes and adjust after exertion and due to individual self-control, effect of these variables become disinterested.

Conclusion

We conducted an experiment to estimate lactate production during a lactate tolerance swimming test in swimming players. Our results showed a significant increase in blood lactate just after the test; and decreased to below of baseline 24 hours after the test.

Abbreviations

ELIZA: Enzyme-Linked Immunosorbent Assay

L: Litter

LET: Lactate Tolerance Exercise Test

Mg/dl: milligram/deciliter

mmol: millimole

REC: RECord

RF: Repetitions to Failure

RM: Repetition Max

RNF: Repetitions Not to Failure

SD: Standard Deviation

μmol: micromole

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Author contribution

Asghar Nikseresht: Design of study, proposal of study writing, final content of study

Imman Yabande: proposal of study writing, enrolled data, manuscript writing

Karamatollah Rahmanian: Design of study, proposal of study writing, analysis, interpretation, manuscript writing, final content of study

Abdolreza Sotoode Jahromi: proposal of study writing, interpretation, final content of study

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