THE PHYSIOLOGICAL RESPONSE OF THE ORGANISM TO ANAEROBIC LACTATE LOAD IN WATER AND ON DRY LAND

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Keywords:

- *creatin kinase,*
- *urea, lactate,*
- *swimming,*
- *running,*
- *triathlon.*

Abstract:

The aim of the study was to highlight the physiological response of the body to the anaerobic lactic load at different outdoor environments. The examined group consisted of 11 performance triathletes. Swimming and running load, in terms of duration and intensity was the same. After running load we have seen an increase of creatine kinase levels by 69% and after swimming load of 8% above the reference value. Among achieved values of creatine kinase after swimming and running load showed a statistically significant difference ($p < 0.01$). Among the achieved values of urea after swimming and running load did not show a statistically significant difference. With this paper we wanted to highlight the possibility of using biochemical indicators of creatine kinase and urea to diagnose the current state of the organism in swimming.

INTRODUCTION

The control of sport training requires assessment of internal responses of the organism to a specific training load. Monitoring of physiological response is essential because individualization of intensity load in a given period of the annual cycle in a particular sport.

Blood tests are diagnostic method that allows to obtain important information on the response of the organism to the training load. Most often we identify blood lactate and creatine kinase. The human body is constantly producing small amounts of lactate – 0,8 mmol.l-1 [15] or 1,2 – 2 mmol.l-1[10]. For activities with a high levels of intensity is a major part of the energy obtained by the process of anaerobic glycolysis [6] during which lactic acid is produced. In the sport practice, concentration of lactate in the blood is a key indicator that is used to assessing muscle activity. Lactate values give information about activation and share of aerobic and anaerobic system [2, 19, 20].

The release of energy from creatine phosphate (PCr) is catalyzed by creatine kinase enzyme, which is involved in the separation of phosphorus from creatine. The energy released by separating the phosphorus is used to add phosphorus to the ADP to create new molecules of ATP [12].

Elevations in levels of creatine kinase (CK) is proportional to the size of the necrotic process. Elevated CK values are determined for greater physical activity and adjustment emerges sometimes up to seven days. It is possible to evaluate the ability of the organism to adapt to physical load and anaerobic metabolism during dynamic monitoring of the CK values [3]. According to autors Brancaccio et al. [1] the level of CK is increasing because of damaged sarcolemma, thus the enzyme gets into the blood stream. Newham [16] argues that after physical load may CK levels in blood reach 5 to 50 times of the reference value. According Kapounková [11] the length and intensity of the load is not the only cause

elevations of creatine kinase. The load must be accompanied by mechanical damage to sarcolemma (contact with a solid surface - gives rise to microtrauma). That may be caused by metabolic and mechanical causes. The metabolically exhausted muscle fibers exhibit a drop in the membrane resistance after a increased internal free calcium ions which promote the activation of the potassium channel [4,5]. Another mechanism may be a local damage of muscle tissue. CK is an indicator of muscle necrosis and its level increases with its amount [13]. The cause of elevated CK values after a physical load may cause other factors such as tissue hypoxia, depletion of muscle glycogen, lipid peroxidation, accumulation of free radicals [21].

Urea is the end product of protein breakdown, which takes place in the liver. If longer intensive sport load results in an energy deficit, due to lack of glycogen or low carbohydrate intake, the breakdown of body proteins increases. As a result of this metabolic process, concentration of urea in the blood increase. The concentration of urea in the blood and excretion of 3-methylhistidine are markers of the total protein catabolism or myofibrillar protein catabolism [18].

Neumann et al. [15] reported that when the body is unable to deal with the load, residual fatigue is increasing. Protein degradation processes dominate over their creation, which ultimately leads to a gradual increase in blood urea concentration. During the regular performance training blood urea achieves concentrations 5 to 7 mmol/l. If the concentration is above 9 mmol/l (in women over 10 mmol/l), the intensity of a training load need to be reduced, or the training process must be stopped. The concentration of urea in the blood is an individual variable and thus must also be considered. The urea concentration increases according to the length and intensity of the training load.

The goal was to highlight the differences in physiological responses of lactic anaerobic organism load in a different external environmentand thereby contribute to the knowledge on the assessment of fatigue states in managing the training process.

THE AIM OD THE WORK

The aim of the study was to highlight the physiological response of the body to the anaerobic lactic load at different outdoor environments.

THE MATERIAL AND THE METHODOLOGY

The group consisted of 11 performance triathletes senior category (aged 18-26 years), who specialize in Olympic triathlon. Basic somatic characteristics and performance indicators are presented in Table 1.

Tab. 1 Research group

$\bar{x}$	Age [years]	Weight [kg]	Height [cm]	Athletic age [years]	400free swim [s]	1km run [s]
	22.63	76.90	184.18	10.18	291.36	183.18
med	23	78	184	10	290	185
s	3.22	4.14	5.99	1.89	10.98	5.30
max	26	84	195	13	310	190
min	18	70	175	7	275	172

The experimental factor was created by anaerobic lactate load protocol at different external environment, the impact of which we evaluated by monitoring changes in levels of CK and urea 12 hours after a completion load.

Protocol of anaerobic lactate load:

swimming load (25m pool): 6x75m; intensity- 95% from maximum; rest interval - 4 min., running load (running track): 6x350m; intensity- 95% from maximum; rest interval - 4 min. For evaluating the intensity load, we performed sampling of capillary blood in 3th, 7th, 9th a 20th min (levels of blood lactate) similarly as Maglischo [14]. The highest values of blood lactate was recorded in the seventh minute after load. Mean blood lactate after swimming was loaded 12.7 ± 3.7 mmol/l, after running load 13.2 ± 1.99 mmol/l.

We performed collection of physiological samples (capillary blood), to determine the urea and creatine kinase after 12 hours of finishing the load.

Before applying experimental factor any of probands did not complete any training load at least 48h. The values of lactate levels was evaluated using the device Accutrend lactate. The device works on the principle of enzymatic-amperometric determination of lactate in fresh capillary blood - called. reflex photometry. Measurement range is from 0.8 to 22 mmol/l in the blood. The manufacturer's stated accuracy in the range of 3 to 8%, depending on the concentration of lactic acid in capillary blood.

CK and urea were measured by staff of the national Sports Centre on Reflotron Plus analyzer.

The principle of measurement is to use reflective photometer, which measures the reflectance using an Ulbricht sphere with reference beam to compensate. The measuring accuracy is ≤ 0.2% reflectance. We evaluated obtained data with basic statistical characteristics. To detect differences in observed values, we used the nonparametric Wilcoxon signedrank test.

RESULTS AND DISCUSSION

CK values after swimming load: average 4.03 ukat/l 37 ° C; Median 3.53 ukat/l 37 ° C; standard deviation of 1.46 ukat/l 37 ° C, and the reference value of these levels for the general population is from 0.40 to 3.25 ukat/l 37 ° [7].

Probands in the study group reached an average value 8% higher than the reported reference values. We believe that this increase could be caused by repeated reflection from the wall in turn, where there could be some mechanical disruption of the integrity of the sarcolemma, which could result in increased CK levels in blood.

The blood urea after swimming load: the arithmetic mean of 5.84 mmol/l; median 5.49 mmol/l, the standard deviation of 1.31 mmol/l; the reference values of the level of urea for the general population are 1.7 - 8.3 [8]. One from a proband group reached higher values than reported benchmarks. We believe that the length of the load was sufficient to process protein breakdown prevailed over their creation, which could cause the blood urea has not received over the reference value. Statistical characteristics of the group after swimming load are presented in Table. 2.

Tab. 2 Levels of creatine kinase and urea after swimming load

	Swimming	
	CK [ukat/l 37 °C]	**Urea [mmol/l]**
$\bar{x}$	4.03	5.84
med	3.53	5.49
s	1.46	1.31
max	6.99	8.49
min	1.90	4.23

CK values after running load was; arithmetic average 11.49 ukat/l at 37 °C, the median 10.5/l 37 °C, standard error 5.3 ukat/l 37 °C, and the reference values for the general population are 0.40 to 3.25 ukat/l 37 °C [7]. Probands in the study group reached an average

value which is 69% higher than the reported reference values. We believe that this increase was mainly due to sarcolemmal disruption, enabling CK flow out in the blood.

Urea values after running load was; average 5.02 mmol/l, median 4.76 mmol/l, standard error 1.42 mmol/l, and the reference values for the general population are 1.7 – 8.3 mmol/l [8]. We believe that the length of the load was sufficient to process protein breakdown prevailed over their creation, which could cause the blood urea has not received over the reference value. Statistical characteristics of the group after running load are presented in Table. 3.

Tab. 3. Levels of creatine kinase and urea after running load

	Running	
NAME	**CK [ukat/l 37 °C]**	**Urea [mmol/l]**
$\bar{x}$	11.49	5.02
med	10.5	4.76
S	5.3	1.42
max	21.9	8.65
min	4.45	3.33

From the measured values we found statistically significant difference ($p < 0.01$) between the level of CK after swimming and cross-country load (Fig. 1). CK levels after cross-country load compared with swimming load amounted difference of 66.4%. We believe that high CK after cross-country load have been predominantly caused by mechanical destruction of the sarcolemma, which was caused by foot strike on a firm surface. In swimming there is direct contact with the solid surface only in turns, from which we conclude that disruption of sarcolemmal be smaller in scale compared to running.

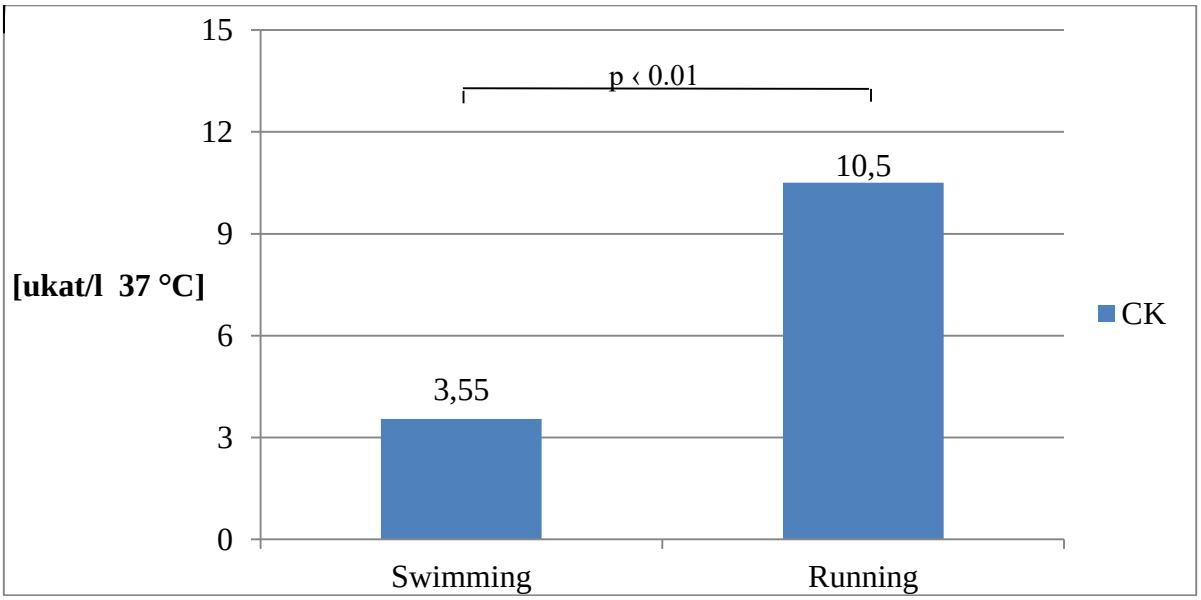

Fig. 1. Levels of (Median) creatine kinase after swimming and running load

From the measured values, we did not find a statistically significant difference between the level Urey after swimming and running load (Fig. 2). Change in blood urea after running load compared with swimming amounted to 13.3% of the difference. The measured values of urea after running and swimming load ranged benchmarks (excluding probands P.Ď - after

swimming load and L.L.- after running). We believe that blood urea after anaerobic lactate load can only provide additional information for assessing fatigue of organism.

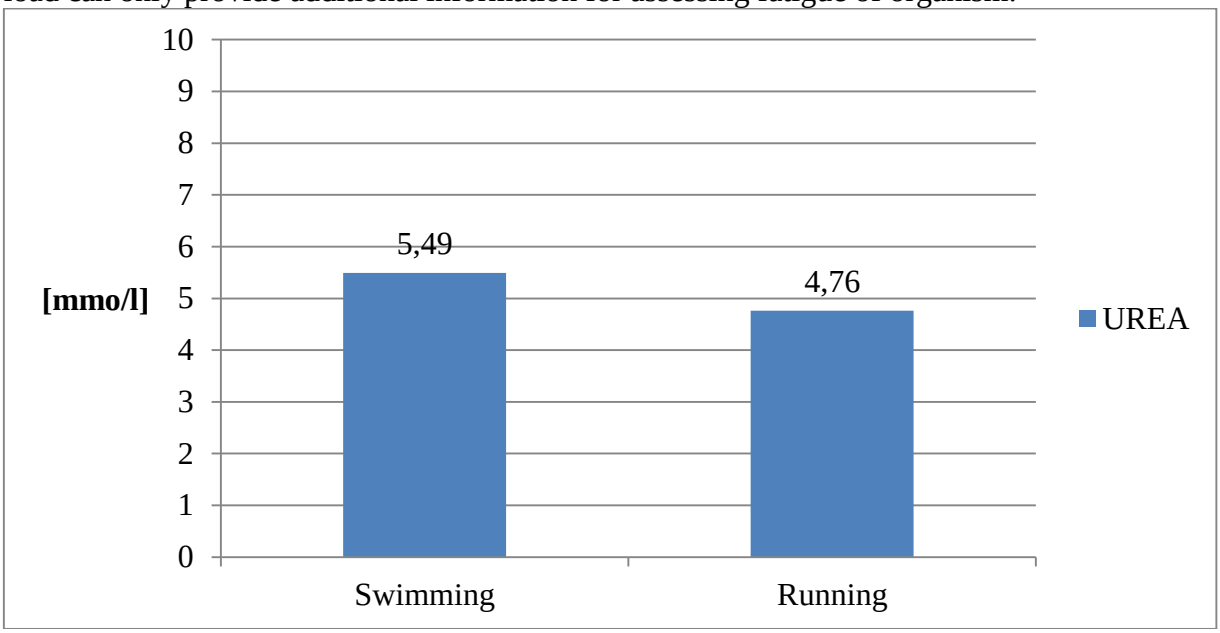

Fig. 2. Levels of (Median) urea after swimming and running load

Pantoja et al. [17] studied the measurement of CK levels after the same load in water and on land, they compare impact of exercising in water an on the dry land to level of CK in 9 mans of age 23 ± 1.58. Perform flexion and extension at the elbow joint in water and on land in 3 sets of 10 repetitions. Rest between sets was 2min. Experienced a statistically significant increase in CK levels after exercise on land. After a workout in water, they found no statistically significant difference in CK levels before and after exercise. Study informs about statistically significant difference between CK levels on land and in water. Results of this research, similar to the results of our work points on a different levels of CK after similar load in water and on land. Clarification of the causes of the elevated CK levels need further investigation taking into account factors other than mechanical damage to the sarcolemma.

CONCLUSIONS

The goal was to highlight the differences in physiological responses of the body to the same anaerobic lactic load at different outdoor environments. After completing both types of load, swimming and running, we have seen significant difference in CK levels after running load compared to swimming. We have not noticed significant difference between the values of urea for both types of loads.

Although the difference between the values of CK after running and swimming load was significant, 8% increase in CK over the reference value after swimming load indicates a certain possibility of using CK as an indicator of fatigue and in swimming. Subject to further research may therefore be objectified criteria for assessing CK after loading in the aquatic environment.

We recommend for further research to establish basal values of CK and Urea separately for each proband and thus minimize the possible impact of other factors that could affect the levels of CK and Urea.

A suitable extension for this research in triathletes group could be watching the response of the body through the monitoring of indicators also for cycling.

Autors Chrismas et al. [9] compare two different statistical methods (CV –coefficient of variation and ICC – „intraclass correlation coefficient“) to verify reliability of CK levels.

Coefficient of variation shows only low level of reproducibility 20%. On the other hand „intraclass correlation coefficient“ was 0.90 indicating a high level of reproducibility. The authors explain this inconsistency, that individual changes in CK levels may not be caused by damaged muscle fibers, but may be due to inherent variability. Areas for further research could be clarified variability CK levels after physical load on land and in water.

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