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Original Study

Anaerobic Threshold Determination by Direct Blood Lactate Measurement Without Warm up Protocol in Female Athletes

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SUMMARY

Introduction: The anaerobic threshold (AT), determined by the direct blood lactate measurement, is of huge practical significance during the training test with the aim to estimate the training status of the female athletes.
Aim: The aim of this research was to determine anaerobic threshold by direct blood lactate.
Material and Methods: Academic research included 20 female subjects divided into four groups: I group – 10 non-trained subjects, who were not previously subjected to the warm up protocol, II group – 10 well-trained subjects who were not previously subjected to the warm up protocol of Conconi test.
Results: Results obtained and presented in this paper show that AT, determined by the direct blood lactate measurement, is statistically significant ($p < 0,001$) in higher values of the heart rate in well- trained subjects compared to the non-trained subjects not subjected.
Conclusion: According to the aforementioned authors the Conconi test can be used nonetheless because of its easy administration with the precondition to provide the adequate interpretation in the assessment of the training capability in all sports activities.

Keywords: Anaerobic Threshold, Blood Lactate, Female, Athletes, Conconi Test

INTRODUCTION

Anaerobic threshold is the load where the concentration of the lactic acid reaches a critical value of 4 mmol/l, which is called lactate threshold - LT and denotes the start of its accumulation in the blood.

The anaerobic threshold (AT), determined by the direct blood lactate measurement, is of huge practical significance during the training test with the aim to estimate the training status of the female athletes.

The levels of most quantitative parameters related to muscles and activities are lower in women than those measured in men [1]. Muscle capacity is defined by three basic consepts: power, strength, and endurance [2,3], and it greatly depends on the supply of the nutrients to the muscles, that is, on the glycogene deposited in the muscles prior to the

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exerted work [4] and the adequate function of the cardiovascular system.

There are three metabolic systems for replenish ATP: phosphocreatinin – creatinin and glycogen – lactic acid, which are anaerobic systems, and the aerobic system. The first two anaerobic systems are used by a muscle in short term activity and for a longer activity aerobic system of energy generation is utilized (by means of the oxygen derived from the nutrients whereby great quantity of energy is released [1,4,5]. Muscles use aerobic energy supply but \ intense physical activity results in lack of oxygen and activation of anaerobic system. That breaking point when the aerobic system of energy supply is transformed into the anaerobic system is called the AT [6,7,8]. Anaerobic sytem increasingly generates lactic acid which is accumulated in muscles and then in blood. When the anaerobic threshold is surpassed it is not possible to endure long in this intensity regime. Anaerobic threshold is reached before the maximal oxygen consumption, VO2 max so it is expressed in % of VO2 max [6,7,8,9].

The recovery of energy systems in muscles after training load is a complex chemical process that implies the elimination of excessive lactic acid and replenishing of the used oxygen ('oxygen debit'), and the replenishment of the glycogen reserve [4,10].

Concept of Anaeroboc Threshold – AT was introduced for the first time in the sixties of the last century, first in the clinical practice and then in sport [11, 12]. In the glycogen – lactic acid system energy needed for the resynthesis of ATP is drawn from the carbohydrate breakdown, but only to the pyruvic acid which is then converted into the lactic acid (acidum lacticum) [13]. Nowadays, it is well known that the lactate concentration serves as an estimation of the training condition of the athlete [14]. Workload intensity increase in respiratory coefficient and the exponential increase of pulmonary ventilation is designated as the anaerobic threshold [15]. Anaerobic threshold is the load where the concentration of the lactic acid reaches a critical value of 4 mmol/l, which is called lactate threshold - LT and denotes the start of its accumulation in the blood [16].

AIM

The aim of our research was to determine AT in an adequately administered test of load and heart rate monitoring, by direct method of the blood lactate measuring in female subjects (well trained and untrained ones), of the federal rank of competition in collective sports (basketball, handball, volleyball and football) without prior warm up procedure on the values of the subjects' anaerobic threshold.

MATERIAL AND METHODS

The academic study was approved by the ethics committee No OI 179019.

Research included 20 female subjects divided into four groups:

I group – 10 non-trained subjects, who were not prior subjected to the warm up protocol;

II group – 10 well- trained subjects who were not prior subjected to the warm up protocol.

Non-trained subjects complied to the following demands: that they are healthy, they are over 18, and they have given prior written consent to participate in the research.

Well- trained subjects complied to the following demands: that they are healthy, that they are capable of training and competing, are on the senior team in the federal rank of competition, are older than 18, are competing in basketball, handball, volleyball and football.

All subjects were measured for body weight, body height and age.

First group of subjects (non-trained) started the test without warm up, with the initial workload of 20W, and each minute the load was increased by 20W. Heart rate and blood lactate were measured after each minute.

Second group of subjects (well-trained) started the test without the warm up protocole.

The warm up protocole included riding a cycle ergometar with the workload of 20W and the increase of the workload by 20W each minute until heart rate (HR) reached 50% of the maximal heart rate for the given age.

Following variables were observed:

- Heart rate (HR) by pulse measuring,
- Concentration of blood lactate and
- Current workload expressed in power unit (W) in each lap time (in each susequent minute of the workload).

All variables were determined before the test, in any change of the workload, and in

Subjects	N	Age	Weight (in kg)	Height (in cm)
Non-trained	25	22, 75±3,42	61,88±5,29	162,52±4,91
Well-trained	25	23, 18±4,37	62,87±4,67	164,42±5.07

Table 1. OAge, body characteristics (weight and height) of the subjects tested on blood lactate and heart rate in workload protocol

Subjects	Without prior warm up
Non-trained	(I) 138±5,91 (N=10)
Well-trained	(II) 154±4,17* (N= 10)

Table 2. Value of the anaerobic threshold determined by the direct blood lactate measurement (4 mmol/l) in non-trained and well-trained subjects of the federal rank of competition

the end of the test.

Concentration of the blood lactate was determined at the onset of the test and after each minute of the test (immediately before the next workload increase). Test was abrupted the moment measured blood lactate concentration was ≥4 mmol/l. Blood samples were taken from the fingertips by capilet and then transferred to lactate – test strips that were then inserted into the lactate analyzer - Accutrend Menheim and the values of lactates were read in 60 sec. Lactate analyzer was calibrated according to the known and set lactate standards (0,5 and 15mM).

The Student T test was used for statistical data processing, because the data distribution was normal. All quantification values obtained were registered as mean values and standard error, and statistical significance. The value of $p< 0,05$ was considered statistically significant. The obtained results were shown in Tables.

RESULTS

Age, body weight and body height of the subjects were determined before the start of the testing, they were statistically processed and shown in Table 1.

The table shows homogeneity of the subjects groups, without statistical differences in age (22 -23), weight (61 – 62 kg) and height (162 – 164 cm), which makes possible the confirmation of the results validity.

Table 2 shows that there is a statistically significant difference between the well-trained and non-trained subjects who were, prior to the test, subjected to the warm up protocol, that is, the anaerobic treshold was determined by the direct measurement of blood lactate which is significantly higher than ($p<0,01$) in well-trained when compared to the non-trained subjects.

DISCUSSION

Results presented in this paper show that AT, which was determined by the direct measurements of the blood lactate is statistically significantly formed ($p < 0,01$) at higher values of the heart rate in well trained subjects when compared to the non-trained subjects, This complies with the results of some other authors, that is, organism is capable of reaching the maximal increase of power in a short period of time, whereby later on this power drastically decreases [4, 17]. In active muscles aerobic and anaerobic abilities are increased by totally 45% [1,10].

The process of lactate creation from the pyruvat is increased and the lactic acid is accumulated during high intensity workload, which results in acidosis [12]. This training intensity develops a high level of the aerobic – anaerobic capacity, such as the one in the elite athletes [1, 9, 10].

Nowadays, it is well known that the concentration of the blood lactate in competitive or training workload is attributed a vital role. Based on changes in blood lactate levels one estimates the training capacity of the athletes [18,19], especially in the cyclic type of activities, and the results of this research undoubtedly point out to this fact.

The application of the functional diagnostics in the athletes represents one of the preconditions of the successful training process implementation. Determination of the blood lactate concentration as a metabolic information is nowadays, due to the advance of the technology, easy and convenient procedure to administer in the labaratory but in the field as well [20]. Contemporary trends in the physiology of sport tend to favour simpler and less traumatic methods, so the focus of attention is directed towards the non-invasive methods of AT determination, although one can say that they do not have real verification of the scientific public. The best-known non-invasive method of determining AT is the Conconi test, the validity of which has not yet been adequately assessed.

The direct method of determining AT by measuring blood lactate level is a reliable and accurate method, but it requires special prerequisites because it represents a case

of the so-called „bloody method" so it is more appropriate in the routine work in sport to administer the indirect, non- invasive methods such as the Conconi test. Rosić et al [21] have shown that heart rate values at which AT occurs, are statistically higher ($p<0,05$) compared to the values when AT is determined by the blood lactate measurement. According to the aforementioned authors the Conconi test can be used nonetheless because of its easy administration with the precondition to provide the adequate interpretation in the assessment of the training capability in all sports activities.

CONCLUSION

Results obtained and presented in this paper show that AT, determined by the direct measurement of blood lactate level, is statistically significant ($p < 0,001$) in higher values of the heart rate in well- trained subjects compared to the non-trained subjects not subjected.

The method of direct AT determination by blood lactate measurement is the most accurate and reliable method. It can and should be applied in the training process when assessing the level of training of athletes.

CONFLICT OF INTEREST

All authors declare no conflict of interest.

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Određivanje anaerobnog praga direktnim merenjem laktata u krvi bez protokola zagrevanja kod sportistkinja

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KRATAK SADRŽAJ

Uvod: Anaerobni prag (AT), određen direktnim merenjem laktata u krvi, je od ogromnog praktičnog značaja tokom trening testa sa ciljem da se proceni status treninga sportistkinja.
Cilj: Cilj ovog istraživanja bio je da odredi anaerobni prag direktnim merenjem laktata u krvi.
Materijal i metode: Istraživanje je sprovedeno na uzorku od 20 žena podeljenih u dve grupe: 10 neutrenuranih sportistkinja i 10 utreniranih sportistkinja. Za određivanje anaerobnog praga korišćen je Konkoni test, i to bez protokola zagrevanja pre testa.
Rezultati: Dobijeni rezultati i predstavljeni u ovom radu pokazuju da je anaerobni prag (AT), određen direktnim merenjem laktata u krvi, statički značajno na višim vrednostima srčane frekvence kod dobro utreniranih sportistkinja u odnosu na neutrenirane ($p < 0,001$).
Zaključak: Prema pomenutim autorima, Conconi test se ipak može koristiti zbog njegove lake primene,, što je preduslov da se obezbedi adekvatna interpretacija u proceni sposobnosti treninga u svim sportskim aktivnostima.

Ključne reči: anaerobni prag, nivo laktata u krvi, žene, sportistkinje, konconi test

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