

# CHANGES IN THE PHYSIOLOGICAL PROCESSES DURING TRAINING AND OFFICIAL COMPETITIONS IN YOUNG KARATE ATHLETES

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**Abstract:** It was conducted functional and anthropological tests on a sample of ten male karate athletes aged between 15-18 years, with long training experience, and who are candidates for the National Team of the Republic of Macedonia. The research was conducted so that the dynamics and changes in the heart rate and blood lactate levels of the karate athletes can be determined during training and during official competition. The differences in the values of blood lactates and the heart rate which emerged during training and official competition are determined by using the T-test. The resulting values for the blood lactate level show a statistically significant difference during training and official competition in all measurements at the level  $p < 0.00$ . The same conclusion applies to the heart rate values, where we can also register a statistically significant difference in the values gathered during training and during official competition ( $p < 0.00$ ) as well as after warm up and after the measurements in all three fights.

**Key words:** karate, blood lactates, heart rate, training, competition.

## INTRODUCTION

Karate is one of the most popular individual sports in the world. The dynamics during the fight and the high frequency of movements by the karate players requires having a high level of motor and functional abilities with a special emphasis on the speed, power and coordination.

The success in any sport and thus also in karate depends on the mutual action of several factors: techniques, tactics, speed of decision making and mental abilities, but it certainly also depends on the physiological characteristics of the karate player. It is known that the best karate players are characterized by the highest level of readiness (Chaabene, Hachana, Franchini, et al. 2012) which entails the role of the high level of development of aerobic as well as anaerobic abilities (Beneke, Beyer, Jachner, Erasmus & Hutler, 2004). It can be said that the physiological parameters may have a key role in the observance of the performance in the training program and the readiness of the karate athletes to perform at official competitions. According to recent researches (Beneka et al, 2004), the structural profile of the acyclic activity of the karate fight suggests that the aerobic metabolism is the dominant source of energy with anaerobic compensation, mainly energy rich in phosphates. The already mentioned purpose of this research is to determine whether the young karate athletes experience various changes in certain physiological parameters during training and during the official competition.

## MATERIAL AND METHODS

The research was conducted on a sample of ten experienced karate players at the age of 15-18 years, candidates for the national team of Macedonia. Anthropological and functional tests were made for the realization of this research, with the main objective to determine the dynamics and the changes that occur in heart frequency and the levels of blood lactate in young karate players during and after the fights in the official competitions. In accordance with the set aim of the research, hypothesis was made that there are statistically significant differences in the functional abilities during training fights and after official competitions. The following sets of indicators were measured for the realization of this study:

- general anthropometric characteristics: body height BH, body mass BM, Body mass index ( $\text{kg}/\text{m}^2$ ) – BMI.  
 - functional abilities: maximum oxygen consumption  $\text{VO}_2\text{max}$ , oxygen saturation%  $\text{SpO}_2$ , hemoglobin level Hg g/dl, heart frequency HF and blood lactate level L.

During the research, all competitors were in good health condition and all of them gave written consent for participation in the study.

During the training, each respondent made three fights in his weight category of two minutes and two minutes break between each fight (just as in the official matches), with a judge supervising the fights. Before the start of the research, the respondents were warming up 15 minutes in the following sequence: 5 minutes running, 5 minutes general preparation exercises and 5 minutes specific karate exercises. The blood sample was taken by the medical laboratory technician immediately after the warm up and after each fight. The lactate analyzer Lactate SCOUT + EKF Diagnostics was used for the determination of the level of lactate in the blood and NONIN Onyx for the determination of the oxygen saturation. The oxygen consumption was determined with indirect method using Agility shuttle Run test. The height and weight of each respondent was measured using stadiometer (Stadiometer, SECA, Leicester, UK) and electronic scale. All measurements were conducted in the Office of Sports Medicine (Laboratory of Sports Medicine) at the Faculty of Medicine-Skopje.

### STATISTIC ANALYSIS

The obtained values of the measured variables, the characteristics and the size of the samples determined the manner and method of processing the results. The central and dispersive parameters are shown as mean values and standard deviations. The normality of the distribution of the results is calculated with the Kolmogorov-Smirnov method. The differences that emerged during the training and after the official competition were determined with the t-test. The statistical processing of the results is calculated by applying the statistical package program SPSS for Windows, Release 15.0; SPSS, CHICAGO, IL, USA.

### RESULTS

Ten karate athletes who are candidates for the national team of Republic of Macedonia were supervised in their competitive part in the annual periodization, before their participation in the World Karate Championship which is to be held in Jakarta, Indonesia in 2015. All karate athletes were males, with an average age of 16.10 years, body height 177.50 cm, body weight 67.60 kg, i.e. BMI of 21.45. Based on the results from the Kolmogorov-Smirnov method, we can conclude that there is normal distribution of the results, which points to the fact that it is a matter of homogenous group of respondents, i.e. there is no deviation in their anthropological and functional characteristics in relation to their age category.

*Table 1. Key features and anthropological measures of the participants in the survey*

Parameters	Average values $\pm$ SD	max D	K-S
Age	16.10 $\pm$ 1.20	0.32	$p > .20$
Body height (cm)	177.50 $\pm$ 5.54	0.19	$p > .20$
Body weight (kg)	67.60 $\pm$ 8.73	0.17	$p > .20$
Body mass index ( $\text{kg}/\text{m}^2$ )	21.45 $\pm$ 2.49	0.22	$p > .20$
$\text{VO}_2\text{max}$	49.67 $\pm$ 6.04	0.19	$p > .20$
Hg (g/dl)	14.43 $\pm$ 1.15	0.15	$p > .20$

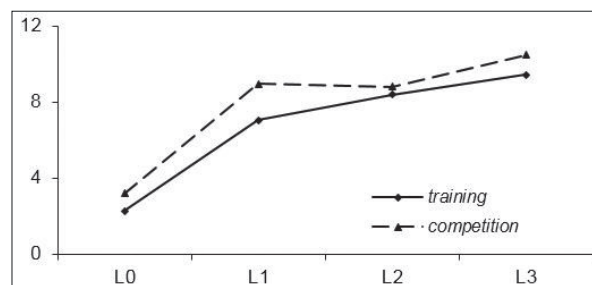
The level of lactates in the blood statistically differs significantly during the training matches and the official matches in all measurements i.e. after the warm up, after the first fight, after the second fight and after the third fight. ( $p_1 < 0.003$ ,  $p_2 < 0.000$ ,  $p_3 < 0.000$ ,  $p_4 < 0.000$ , separately) The values of the lactates after the warm up in the trainings in this study resulted with 2.29 mmol/L, while in the official competitions they resulted with 3,20 mmol/L. These results have similar values with the results obtained previously in similar studies when athletes from several martial arts

were analyzed (Eaton con Sterkowitz 1997; Kreamer et al, 2001; Aziz et al, 2002; Karninčić et al, 2009) The lactate values obtained after the first two fights and at the end of the fights are very similar with the values obtained from the previously made analyzes made on competitors from related martial arts. (Yoon et al., 1994; Eaton con Sterkowitz et al., 1997; Da Lima et al., 2004; Karninčić et al., 2009.) After the third fight, the middle values of the lactates resulted slightly higher (9.43 and 10.49 mmol/L), i.e. during the training from 5:40 to 12.60 and after the official competition from 7.10 to 17.70 mmol / L.

**Table. 2.** Values of lactate during training and during competition

Parameters	Average values $\pm$ SD	max D	K-S
Age	16.10 $\pm$ 1.20	0.32	p > .20
Body height (cm)	177.50 $\pm$ 5.54	0.19	p > .20
Body weight (kg)	67.60 $\pm$ 8.73	0.17	p > .20
Body mass index (kg/m <sup>2</sup> )	21.45 $\pm$ 2.49	0.22	p > .20
VO2max	49.67 $\pm$ 6.04	0.19	p > .20
Hg (g/dl)	14.43 $\pm$ 1.15	0.15	p > .20

**Graph 1.** Values of lactate during training and during competition



The higher levels of lactates obtained during the competitions are probably due to the higher motivation of the competitors and also their will to do their best so that they reach the criteria for entry in the national team, i.e. a greater overall engagement of the competitors during the official competition. (Marić et al., 1985; Sharrat et al., 1986; Nilsson et al., 2002.)

In this study, we can see that there is a significant increase in the lactates only after the warm up and immediately after the first fight. The results obtained after the second and the third fight are more stable with a slight increase from fight to fight. What is noticeable is that the results in lactate values have the same behavior during training and during official matches. The obtained results indicate that in the competitive part of the training period the usage of the interval method with submaximal and maximal effort during training justifies the expectations for good specific preparation of the karate athletes. The similar way of work during the trainings which corresponds with the manner and the approach during the official competition fights, has great contribution for the athletes to adapt and raise their lactate tolerance level and their anaerobic tolerance level higher and thus increase the energy potentials and elimination and place the balance in the excretion of lactic acid higher in their individual functional abilities. With this method we can also improve the tactical-technical part of work of the karate players. It can also be said that the increase of lactate concentration in the blood is determined by the physical exertion, i.e. taking in consideration the fact that the excretion of lactates is faster than their removal during intense muscular effort (Klisuras, 2013). Table 3 shows the values of the oxygen saturation during different efforts, measured immediately after the end of the fights. By analyzing the data it can be concluded that no statistically significant difference is registered in the values of oxygen saturation (SpO<sub>2</sub>) during the training fights and the official competitions for all four measurements.

The arterial blood gases are measured using the noninvasive method for monitoring the oxygen saturation and the results show normal values of 95-99. Values below 90-91 which are considered abnormal are not obtained during the training or during the official competitions. This indicates that regardless of the level of effort, the respiratory

system provides an adequate oxidation of blood, meaning that primarily the neural and secondary the humoral factors influence the breathing regulation during activity.

**Table 3.** Values of oxygen saturation during training and competition.

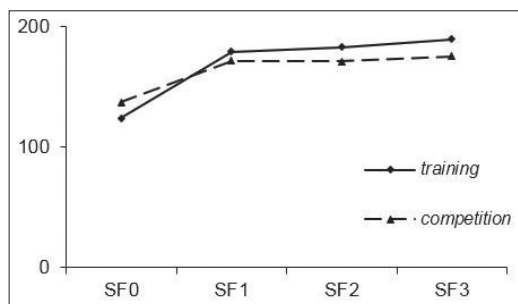
Parameter	During training	During official competitions	P
SpO <sub>2</sub> 0	96.70 ± 1.42	96.00 ± 1.63	NS
SpO <sub>2</sub> 1	96.20 ± 1.48	96.90 ± 2.18	NS
SpO <sub>2</sub> 2	95.80 ± 1.32	95.70 ± 1.64	NS
SpO <sub>2</sub> 3	96.00 ± 1.63	95.40 ± 1.71	NS

The analysis of the data presented in Table 4. And Graph 2, which refer to the values of heart rate, show that there is a statistically significant difference in the values which are gathered during the training fights and during the official competitions ( $p < 0.001$ ), as well as after the warm up and the measurements after the three fights. In the warm up period in both measurements, the competitors reached the level of heart rate over 120 beats/min (during training 124.10 and 137.50 during competition), which means that the karate athletes entered the second zone of effort or sustained maximum preparation for further efforts in both cases. It can be noticed that, in all three fights the athletes have a greater heart rate during the training than during the competition. This occurrence is expected because during training the athletes do not take account of the outcome, but more important emphasis is given to the intensity of work, techniques used, the frequency and the number of attacks and defenses during the match so that they adapt to win points with a larger specter of techniques. Thus they use more effort (submaximal and maximal mode) and therefore the heart rate is increased. During the official competitions, a slightly different situation occurs because each battle has tremendous importance for the karate athletes given that only victory takes them to the next round. Because of that, a greater use of tactical elements is present and the heart rate is slightly lower during the fight.

**Table 4.** Values of heart rate during training and during competition.

Parameter	During training	During official competitions	P
HF 0	124.10 ± 11.23	137.50 ± 18.86	< 0.001
HF 1	179.40 ± 9.08	171.60 ± 14.53	< 0.001
HF 2	183.10 ± 9.75	171.20 ± 10.73	< 0.001
HF 3	189.70 ± 12.80	175.50 ± 20.08	< 0.001

**Graph 2.** Values of the heart rate during training and competition



## CONCLUSION

Based on the obtained results and the analysis we have reached these following conclusions: Statistically significant differences were determined in the dynamics of the heart rate and the blood lactates in all marked periods, which confirms the null hypothesis. This research also determined that the lactates increase significantly only in the

first round, in the measurement performed immediately after the warm up. From the measurements performed after the second and third fight, we can conclude that there is slight increase in the lactate curve and the results are very close to the research made in the related martial arts. The energy systems of glycolysis and the phosphagen system are dominant sources of energy during one karate fight, which leads to the conclusion that athletes adapt to the functional abilities and therefore there is a better distribution of the energy potentials in the second and third fight. Only in exceptional moments of the karate fight the athletes deal with lack of oxygen and oxygen deficiency. In those situations it was noticed that the heart rate has its highest values. Therefore it can be assumed that with certain modification and more frequent use of the interval method of work, the athletes can not only improve their technical-tactical part and the influence in the development of specific skills, but they can also gain quality in the development of specific skills and a greater anaerobic capacity adaptation. With these primarily functional adaptations, the organism of the athletes can develop a bigger tolerance and thereby contribute in the moving of the anaerobic tolerance margin and the lactic tolerance curve, without the occurrence of fatigue of the basic motor skills in the performance of the learned moves, which bring points in the karate fights.

#### **Authorship statement**

The authors have contributed equally.

#### **Financial disclosure**

We declare that we have no conflicts of interest.

## **REFERENCES / LITERATURA**

- Aziz, A. R., Tan, B., & Teh, K. C. (2002). Physiological responses during matches and profile of elite pencak silat exponents. *Journal of sports science & medicine*, 1(4), 147.
- Beneke, R., Beyer, T., Jachner, C., Erasmus, J., & Hütler, M. (2004). Energetics of karate kumite. *European journal of applied physiology*, 92(4-5), 518-523.
- Chaabène, M. H., Hachana, Y., Franchini, E., Mkaouer, B., & Chamari, K. (2012). Physical and physiological profile of elite karate athletes. *Sports medicine*, 42(10), 829-843.
- Lima, E. V. D., Tortoza, C., Rosa, L. C. L. D., & Lopes-Martins, R. A. B. (2004). Study of the correlation between the velocity of motor reaction and blood lactate in different times of combat in judo. *Revista Brasileira de Medicina do Esporte*, 10(5), 339-343.
- Marić, J., & Soršak T. (1985). *Uvođenje metodologije određivanja laktata u krvi kod hrvača klasičnim načinom*. Zagreb: Fakultet za fizičku kulturu. [In Croatian]
- Nilsson, J., Csörgö, S., Gullstrand, L., Tveit, P., & Refsnes, P. E. (2002). Work-time profile, blood lactate concentration and rating of perceived exertion in the 1998 Greco-Roman wrestling World Championship. *Journal of Sports Sciences*, 20(11), 939-945.
- Karnincic, H., Tocilj, Z., Uljevic, O., & Erceg, M. (2009). Lactate Profile during Greco-Roman Wrestling Matchx. *Journal of sports science & medicine*, 8(CSSI3), 17.
- Kraemer, W. J., Fry, A. C., Rubin, M. R., Triplett-McBride, T., Gordon, S. E., Koziris, L. P., & Fleck, S. J. (2001). Physiological and performance responses to tournament wrestling. *Medicine and science in sports and exercise*, 33(8), 1367-1378.
- Klisuras V. (2013). *Osnovi sportske fiziologije*. Beograd: Institut za sport. [In Serbian]
- Sterkowicz, S., & Rukasz, W. (1997). Analysis of the Training of workload plan for judo competitors. *Cracow Academy of Physical Education*.
- Yoon, J. R., Bang, D. D., & Jun, H. S. (1994). The development of sparring types for elite Korean national wrestlers. *Korean J Sports Sci*, 5(2), 15-24.

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# PROMJENE U FIZIOLOŠKIM PROCESIMA ZA VRIJEME TRENINGA I ZVANIČNIH TAKMIČENJA KOD MLADIH KARATISTA

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**Rezime:** Sprovedeno je funkcionalno i antropometrijsko testiranje deset iskusnih mladih karatista 15-18 godina starosti, koji su kandidati za reprezentaciju Republike Makedonije. Istraživanje je sprovedeno tako da su dinamika i promjene srčane frekvence i nivoa laktata u krvi mjereni tokom treninga i za vrijeme zvaničnih takmičenja. Razlike u vrijednostima laktata u krvi i srčane frekvence, koje su se pojavile za vrijeme tokom treninga i za vrijeme zvaničnih takmičenja su određene primjenom T-testa. Vrijednosti nivoa laktata u krvi tokom treninga i za vrijeme zvaničnih takmičenja su pokazale statistički značajne razlike u svim mjerenjima na nivou značajnosti  $p < 0,00$ . Isti zaključak se izvodi i za vrijednosti srčane frekvence, gdje su registrovane statistički značajne razlike u rezultatima dobijenim tokom treninga i zvaničnih takmičenja ( $p < 0,00$ ), kao i poslije zagrijavanja i poslije mjerenja u sve tri borbe.

**Ključne riječi:** karate, krvni laktati, srčana frekvencija, trening, takmičenje.