"IDO MOVEMENT FOR CULTURE. Journal of Martial Arts Anthropology",
Vol. 11, no. 4 (2011), pp. 40–47

Hrvoje Karninčić, PhD
Vocation: Senior Lecturer
Faculty of Kinesiology, University of Split, Teslina 6, 21 000 Split
Scientific interests: wrestling
hrvoje.karnincic@kifst.hr

Mario Baić, PhD
Vocation: Assistant Professor
Faculty of Kinesiology, University of Zagreb, Horvaćanski zavoj 15, 10 000 Zagreb
Scientific interests: wrestling

Hrvoje Sertić, PhD
Vocation: Full Professor
Faculty of Kinesiology, University of Zagreb, Horvaćanski zavoj 15, 10 000 Zagreb
Scientific interests: judo, combat sports

Hrvoje Karninčić[1], Mario Baić[2], Hrvoje Sertić[2]
[1] Faculty of Kinesiology, University of Split (Croatia)
[2] Faculty of Kinesiology, University of Zagreb (Croatia)

Comparison of lactate curves in a wrestling match at the beginning and the end of competition period for elite Croatian Greco-Roman wrestlers

Submission: 12.04.2011; acceptance: 18.04.2011

Keywords: physiology, anaerobic capacity, combat sport, seniors

Abstract
The objective of this research was to compare lactate curves in a wrestling match at the beginning and the end of competition period. Croatian national team of senior wrestlers (n 8) was tested at the beginning and the end of competitive season. Each wrestler wrestled one match and lactates were sampled before the match and after the first, the second and the third round. Results showed that lactate curve is significantly lower at the end of competition period after the second round (9.6 ± 1.6 towards 11.8 ± 0.3 being statistically significant at the level of $p<0.05$) and after the third round (9.2 ± 2.1 towards 12.4 ± 0.2 being statistically significant at the level of $p<0.01$). During the competitive season anaerobic capacity is significantly disturbed and wrestlers can't maintain high intensity of the match. The most important competition occurs in the calendar of events at the end of competition period. We can assume that in those circumstances wrestlers could fail at the most important competition. It is necessary to make corrections to the wrestlers preparation plan and program in order to avoid decrease of anaerobic capacities in the most important moment.

Introduction

Structurally, wrestling can be classified as polystructural acyclic combat sports. During the wrestling match oxidative processes continuously alternate between anaerobic and aerobic depending on the intensity of the match and the working regime [Marić *et al.* 2007]. Trend of increasing the intensity in international wrestling matches is evident in the last few years, and for a number of elite wrestlers this has become specificity of a match tactics at the important competitions. This trend increasingly pushes the sport in anaerobic zone and, accordingly, necessity for control of anaerobic training effects is increasing.

Outstanding questions of intermuscular lactate oxidation, relation of lactate dehydrogenase and mitochondria and intercellular transport lactate, as well as the understanding that lactates are not the cause of acidosis [Robergs *et al.* 2004.] make lactate

measurement in sports diagnostics questionable. Experiments on isolated muscle suggest that acidosis has little detrimental effect or may even improve muscle performance during high-intensity exercise. In contrast, induced acidosis can exacerbate fatigue during whole-body dynamic exercise and alkalosis can improve exercise performance in events lasting 1–10 minutes [Cairns 2006]. Lactate is a useful carbohydrate in times of increased energy demand [Miller *et al.* 2002]. Despite all dilemmas, lactates are indicators for training load, they correlate with duration of performance and they can be regarded as indicators of optimal training stimulus [Bourdon 2000]. The arterial lactate concentration depends on an active muscle mass and exercise mode, but lactate concentration can be maintained at a relatively low level despite high lactate appearance rate during exercise with a large muscle mass because of the large capacity of an active skeletal muscle to take up lactate [Van Hall *et al.* 2003]. Because of its large mass and metabolic capacity, skeletal muscle is probably the major component of the lactate shuttle in terms of both production and consumption. Muscles exercising in a steady state are avid consumers of lactate, using most of the lactate as an oxidative fuel. Cardiac muscle is highly oxidative and readily uses lactate as a fuel, even the brain takes up lactate when the blood level is increased [Gladen 2008]. Successeful wrestlers may be more tolerant of lactate as well as more capable of blood buffering for muscular endurance [Aschenbach *et al.* 2000]. The winner in a wrestling match makes more effort but his better technical level saves energy. It could be the reason why there is no correlation between lactate concentration and success in wrestling. It could be the reason why there is no correlation between lactate concentration and the success in wrestling [Cinar, Tamer 1994; Hübner-Woźniak, Kosmol, 2004]. The release and the uptake of lactate both partake in transmembrane transport. Lactate/H+ transport capacity depends upon the fiber type [Juel 2001], Muscle fibre profile of wrestlers may represent an adaptation based on the specific mechanical and biochemical demands of the long-term training in Greco-Roman wrestling [Mandroukas *et al.* 2010].

For a number of years measurement of blood lactates levels is in use in sports diagnostics and it represents an integral part of some tests for determination of anaerobic threshold, estimation of anaerobic energy capacity and speed of lactate oxidation during recovery. The two most commonly used tests for evaluating the maximum wrestlers' ability to generate anaerobic power are Margaria stair climb (test duration ≈ 1 second) and Wingate anaerobic test (test duration 30 seconds). Duration of a wrestling match is 3×2 minutes and structure activity in wrestling is quite different from these two tests. Blood lactate concentration in wrestlers has been recently used as an indicator of anaerobic power and capacity in successful wrestlers [Yoon 2002].

If initial testing of an athlete's motor ability represents the beginning of his competitive season and the final testing represents the end of the competitive season, it is hard to expect that final testing results will be better than initial testing results due to exhaustion from the competitive season. Although this claim relates to motor abilities the same problem occurs with functional abilities. National calendar of events is usually created in accordance with international calendar of events and the most important competition in season is in fact the end of the most important competition period. For the sport of wrestling, in which anaerobic working regime prevails, it is very important to maintain anaerobic energy capacities at the high level till the end of competitive season.

The objective of this research was to determine if there are significant differences in measured levels of lactates before, during and after the wrestling match, at the beginning and the end of competition period for elite Croatian Greco-Roman wrestlers.

Work methods, sample of subjects

Sample of subjects comprised 8 senior Greco-Roman wrestlers, members of the Croatian national team. Each wrestler represented one of 8 weight classes defined by FILA international rules. Subjects have been practising wrestling, on average, for 10 years and their quality is confirmed by the fact that there were winners of medals from both World Championships and European Championships among them. Anthropometric measures of these sample were taken in earlier research [Karninčić *et al.* 2008]. As we expected wrestlers have relatively low values in the endomorphic and ectomorphic component and are dominantly mesomorphic (Heath-Carter Somatotype (Endo-Mezo-Ecto) 2.55/5.62/1.53).

Sample of variables

Subjects were tested in Split at the beginning of first competition period in December 2007 and at the end of that period in March 2008. Subjects gave their blood samples and levels of lactates were scanned: before the beginning of the first round and after warming up (Lactates 1 December and Lactates 1 March), after the first round (Lactates 2 December and Lactates 2 March), after the second round (Lactates 3 December and Lactates 3 March)

and after the third round (Lactates 4 December and Lactates 4 March).

Data analysis methods

Statistical data analysis was carried out using statistical package Statistica version 7.0. (Softsat, USA). All variables were analysed in descriptive statistics (mean, standard deviation, sample minimum and sample maximum) and tested with the Shapiro – Wilks W test. In order to determine differences in lactate values measured at the beginning and the end of competition period, and in order to determine differences in lactate values between rounds in one test, ANOVA was used for repeated measurements while in post-hoc analysis Fisher's test was used and the results of variables with categorical distribution were additionally tested with non-parametric methods (Friedman, ANOVA).

Description of experimental procedure

Both tests were carried out with the same protocol. The subjects were instructed to follow a normal lifestyle maintaining daily habits, to avoid any medication, alcohol, coffein and vigorious exercise within 24 hours of the test. Athletes reported to the gym in the morning at 10 am after standardized breakfast (840 kJ) consumed 2 hours before the start of the exercise. Warming up in duration of 15 minutes comprised general preparatory exercises - 5 minutes, stretching exercises - 5 minutes, and specific individual and pair exercises - 5 minutes. After warming up, control matches were held in accordance with the current international wrestling rules - three two-minute rounds (30 seconds rest periods between rounds). Each wrestler competed against the oponent from the national team with similar weight, skills and training background. Laboratory technicians took blood samples before the first round and after each round. The amount of lactates in blood was determined using Accutrend Lactate device. Device validity was established by Baldari [Baldari *et al.* 2005]. Sports medicine laboratory "Diomed" from Split was hired for the purpose of this research. Blood samples were taken by medical laboratory technicians. Heart rates were registered to estimate intensity of the workload and were taken using a Polar PE3000 Heart Rate Monitor (Polar Electro Oy, Kempele, Finland). For the purpose of calculation of body mass index, weight and height of subjects were measured. Body weight was measured with medical scale (precision of readings up to 100 g). Martin's antropometer was

Table 1. Shows: number of subjects (n), mean and standard deviation (mean ± SD) and sample minimum and sample maximum (range) for the following variables: Age (yrs), Body mass (kg), Body height (cm), Body mass index and Experience (yrs) of tested wrestlers.

Variables	n	mean ± SD	range
Age (yrs)	8	21±2,2	18 - 24
Body mass (kg)	8	81.1±12.4	64 - 99
Body height (cm)	8	177.5±10.2	163 - 195
Body mass index	8	25.6±1.9	23 - 28
Experience (yrs)	8	10±2.5	6 - 13

Table 2. Results of descriptive statistics and Shapiro – Wilks W test for variables of lactate values in four measurements of wrestlers at the beginning of competition period (December): number of subjects (n), mean and standard deviation (mean ± SD), sample minimum and sample maximum (range), W test value (W) significance level (p) and heart rate.

December	n	mean ± SD	range	W	p	heart rate
La 1 Dec	8	2.8 ± 0.6	1.9 - 3.6	0.9423	$p > 0.05$	108±12
La 2 Dec	8	8.48 ± 0.2	6.2 - 13.8	0.8342	$p > 0.05$	188±9
La 3 Dec	8	11.8 ± 0.3	8.7 - 12.9	0.7527	$p < 0.05$	191±7
La 4 Dec	8	12.4 ± 0.2	10.6 - 14.3	0.9361	$p > 0.05$	192±9

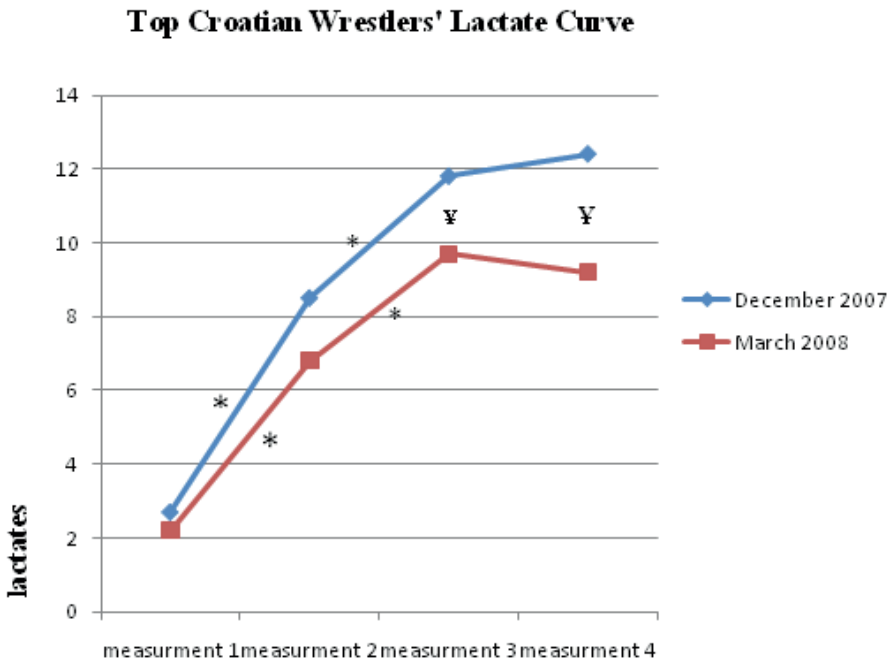
Table 3. Results of descriptive statistics and Shapiro – Wilks W test for variables of lactate values in four measurements of wrestlers at the end of competition period (March): number of subjects (n), mean and standard deviation (mean ± SD), sample minimum and sample maximum (range), W test value (W) significance level (p) and heart rate.

March	n	mean ± SD	range	W	p	heart rate
La 1 Mar	8	2.1 ± 0.7	1.3 - 3.5	0.9566	$p > 0.05$	112±15
La 2 Mar	8	6.7 ± 1.8	3.7 - 9.3	0.9349	$p > 0.05$	190±8
La 3 Mar	8	9.6 ± 1.6	7.6 - 12.0	0.9575	$p > 0.05$	190±6
La 4 Mar	8	9.2 ± 2.1	6,0 - 12,2	0.9684	$p > 0.05$	192±11

Table 4 Results of Fisher's test, which was used in post-hoc analysis after ANOVA for repeated measurements, and results of Friedman ANOVA for verification of categorically distributed variable Lactates 3 December, show differences in level of measured lactates at the beginning and the end of competition period and differences between measurements in one test.

December/March	Fisher	Friedman ANOVA
Lactates 1 December = Lactates 1 March	$p > 0.05$	
Lactates 2 December = Lactates 2 March	$p > 0.05$	
Lactates 3 December > Lactates 3 March	$p < 0.05$	$p < 0.05$
Lactates 4 December > Lactates 4 March	$p < 0.01$	
December		
Lactates 1 December < Lactates 2 December	$p < 0.01$	
Lactates 2 December < Lactates 3 December	$p < 0.05$	$p < 0.01$
Lactates 3 December = Lactates 4 December	$p > 0.05$	
March		
Lactates 1 March < Lactates 2 March	$p < 0.01$	
Lactates 2 March < Lactates 3 March	$p < 0.05$	
Lactates 3 March = Lactates 4 March	$p > 0.05$	

Diagram 1. Lactate curves in Greco-Roman wrestling for elite Croatian senior wrestlers at the beginning and the end of competitive season with the results of ANOVA test for repeated measurements, post-hoc Fisher's test and results of Friedman's ANOVA test.



Statistically significant difference between two measurements in one test (, $p < 0.01$, *$p < 0.05$)
Statistically significant difference in measurements between two tests (¥ $p < 0.05$, ¥ $p < 0.05$)

used for measurement of body height (precision of readings up to 1 mm).

Results

Results distribution analysis via Shapiro – Wilks W for each measured variable confirms that no significant difference between distribution of results of those variables and theoretical normal distribution in the measurement at the beginning and the end of competition period can be found except for the third measurement in December. Relatively uniformed range of results can be noted between sample minimum and sample maximum result for all measurements of lactate values. Due to categorical distribution of results in third measurement in December this variable will be tested additionally, after parametric tests, in non-parametric statistics (Friedman ANOVA).

Discussion

Blood lactate value measured before the match at the beginning of competition period is (Lactates 1 December) 2.7 mml/L and it is not significantly different than the value measured at the end

of competition period (Lactates 1 March) 2.1 mml/L. There is no significant difference between measurement values at the first point but the values are slightly higher at the beginning of competition period which indicates higher intensity while warming up which can be a consequence of better motivation for a match in pre-competition period. In previous researches author measured 2.6 mml/L with both lower quality and higher quality wrestlers. Those measurements were carried out at the beginning of competition period so logically they correspond to our first measurement, while Eaton [according to: Sterkowicz, Rukasz 1998] measured 2.2 mml/L with judokas before the match.

Values measured at the second point of measurement, after the first round, are not significantly different, but again, value measured at the beginning of the competition period (Lactates 2 December) 8.48 mml/L is higher than the value (Lactates 2 March) 6.78 mml/L measured at the end of competition period. Regardless of the amount of difference between the measured values, statistically significant increase of lactates is found after the first round in both periods which indicates high intensity of match in the first round ($p<0.001$ for both periods). Eaton measured 10.0 mml/L in 150 seconds of judo match [according to: Sterkowicz, Rukasz 1998] but the match was 30 seconds longer than in this research.

After the second round, in both periods, statistically significant increase in value of measured lactates was found when comparing to previous round ($p<0.05$) but the values measured at the beginning of the competition period (Lactates 3 December) 11.8 mml/L are significantly higher than values measured at the end of competition period (Lactates 3 March) 9.6 mml/L. It is obvious that intensity in the second round at the beginning of the competition period is considerably higher. Results of other authors, measured approximately at this point, are 14.8 mml/L [Marić, Soršak 1985] and 15.1 mml/L [Artioli *et al.* 2005]. Measured level of lactates is considerably higher, but for the purpose of their research those authors attempted to measure maximal lactate values in the match. Measured value with the lower quality wrestlers was 13.6 mml/L [Karninčić *et al.* 2009] and this value was obtained after the second round, but unlike in this research in that research no statistically significant increase was found when comparing to previous round for the lower quality wrestlers.

After the third round, no statistically significant increase of measured blood lactates was found when comparing to previous round. At the beginning of competition period, measured blood lactates value is (Lactates 4 December) 12.4 mml/L, and again, it is statistically higher ($p < 0.01$) then (Lactates 4 March) 9.2 mml/L measured after the competition period. At the end of the competition period, in the third round, not only that the wrestlers were incapable to put additional energy in the match, but their lactate curve had downward trajectory (diagram 3) which tells us that in this round aerobic work regime prevailed as a consequence of serious decrease in match rhythm. Cause for this can be found in insufficient reserves of muscle glycogen, lower ability to tolerate high acidity (lactate tolerance) or motivation for match after exhausting season. Other authors, after the period o work, measured following lactate values with wrestlers and judokas: 18.2 mml/L [Marić, Soršak 1985], 14.8 mml/L [Nilson *et al.* 2002], 13.0 mml/L [Lutoslawska *et al.* 1998], 13.8 mml/L [Da Lima *et al.* 2004], 15.9 mml/L [Artioli *et al.* 2005], with lower quality wrestlers 13.2 mml/L, and with higher quality wrestlers 12.5 mml/L [Karninčić *et al.* 2009]. Majority of authors found slightly higher results but in their researches duration of work load was longer and some authors attempted to measure maximal lactate values. Mean pre-match heart rates were 108±12, slightly elevated by the warm up. Athletes reached mean post-bouth heart rate: 188±9, 191±7 and 192±9, suggesting that the matches were highly competitive.

There is an interesting data showing that statistically significant increase of measured blood lactate values was found after the first and the second round while after the third round no statistically significant increase was found for both periods (Fisher $1 < 2 < 3 = 4$). This curve responds to the higher quality wrestlers while with the lower quality wrestlers statistically significant increase of blood lactate values was found only after the first round [Karninčić *et al.* 2009]. We can conclude that, regardless of the fact that wrestlers demonstrated significant decrease in anaerobic capacity after competition period, they were still able to distribute energy throughout the match but they were not able to maintain high intensity of the match.

Conclusion

The objective of this research was to determine if there are significant differences regarding lactate levels in a wrestling match at the beginning and the end of competition period for elite Croatian Greco-Roman wrestlers. Tests were carried out on the sample of 8 senior wrestlers, members of Croatian national Greco-Roman wrestling team, at the beginning and the end of competition period. Blood samples for readings of the lactate values were taken during the match. Research showed

that statistically significant difference can be found between measured lactate values at the beginning and the end of competition period, at the end of the second and the third round.

Statistically significant increase of measured blood lactates values was found after the first two rounds while after the third round no statistically significant increase was found for both periods (Fisher 1 < 2 < 3 = 4). We can conclude that elite wrestlers have the ability for tactical engagement in a match (distribution of energy reserves) when anaerobic capacity is decreased, but we can assume that this will not be helpful against wrestlers with high anaerobic capacity who could impose high intensity of the match preferred by some of the wrestlers on the international scene. At the end of competition period, in the second and the third round, intensity of the match significantly decreases so we can conclude that anaerobic capacity is seriously disturbed during the competitive season. In the calendar of events the most important competition occurs at the end of competition period. We can assume that, in those circumstances, wrestlers could fail at the most important competition. This research points out the need for correction of training plan in competition period in order to improve anaerobic capacity so that wrestlers could have on their disposal maximum of their capacities at the most important competitions. Future research should be conducted to determine the lowering of the anaerobic capacity at the end of the competition period which indicates lowering of other wrestlers' abilities.

References

1. Artioli G.G., Coelho D.F., Benatti B.F., Gailey A.C.W., Berbel P., Adolpoho B.T., Lancha Jr, H.A. (2005), *Relationship Between Blood Lactate and Performance in a Specific Judo Test*, "Medicine and Science in Sports and Exercise", 37(5): S99.
2. Aschenbach W.J., Ocel L., Craft C. (2000), *Effect of oral sodium loading on high intensity arm ergometry in college wrestler*, " Med Sci Sports Exerc", 32(3), pp. 669-675.
3. Baldari C., Bonavolonta V., Emerenzijani G.P., Galltta M.C., Silva A.J., Guldetti L. (2009), *Accuracy, reliability, linearity of Acutrend and Lactate pro versus EBIO plus analyzer*, "European Journal of Applied Physiology", pp. 105-111.
4. Bourdon P. (2000), *Blood lactate transition tresholds: concept and controversies, Physiological tests for elite athletes*, "Human kinetics", chapter 4: pp. 50-51.
5. Cairns, S.P. (2006), *Lactic acid and exercise performance: culprit or friend?*, "Sports Med.", 36(4), pp. 279-291.
6. Cinar G., Tamer K. (1994), *Lactate profiles of wrestlers who participated in 32nd European Free-Style Wrestling Championship in 1989*, " J Sports Med Phys Fitness", 34(2), pp. 156-60
7. Da Lima V.E., Tortoza C., Laureano da Rosa L.C.F., Lopes-Martines 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 Brasiliera o da Medicina do Esporte", 10(5), pp. 344-348
8. Gladden L.B. (2008), 200th anniversary of lactate research in muscle, "Exer Sport Sci Rew", 3, pp. 109-15.
9. Hübner-Woźniak E., Kosmol A. (2004), *Blood lactate as an indicator of match intensity in female wrestling*, Athens 2004: Pre-olympic Congress.
10. Juel C. (2001), *Current aspects of lactate axcange: lactete/H+ transpoort in human skeletal muscle*, "Eur. J. Appl. Physiol", 86; pp. 12-16.
11. Karninčić H., Krstulović S., Jašić D. (2008), *Physical Fitness and Anthropometric profile of the Croatian Greeco-Roman Wrestling Team* [Kinesiology research trends and applications], "5th International Scientific Conference on Kinesiology", Faculty of Kinesiology, University of Zagreb, pp. 950-952.
12. Karninčić H., Tocilj Z., Uljević O., Erceg M. (2009). Lactate profile during Greco-Roman - wrestling match, "Journal of Sport Science and Medicine", 8, pp. 17-19
13. Lutoslawska G., Hübner-Woźniak E., Sitkowski D., Borkowski L. (1998), *Relationship between anaerobic capacity and blood lactate following the Wingate test in elite wrestlers during an annual training cycle*, "Biology of Sport", 15(2), pp. 67-74.
14. Mandroukas A., Heller J., Metaxas T.I., Christoulas K., Vamvakoudis E., Stefanidis P., Papavasileiou A., Kotoglou K., Balasas D., Ekblom B., Mandroukas K. (2010), *Deltoid muscle characteristics in wrestlers*, "Int J Sports Med", 31(3), pp. 148-53.
15. Marić J., Soršak T. (1985), *Uvođenje metodologije određivanja laktata u krvi kod hrvača klasičnim načinom* [The Blood Lactate Measuring in Greco-Roman Wrestling Metodology introduction] [in:] Croatian Fakultet za fizičku kulturu, Zagreb.
16. Marić J., Baić M., Cvetković Č. (2007), *Primjena hrvanja u ostalim sportovima* [Application of Wrestling in Other Sports. In Croatian], Kineziološki fakultet sveučilišta u Zagrebu, Zagreb.
17. Miller B.F., Fattor J.A., Jacobs K.A., Horning M.A., Navazio F., Lindinger M.I., Brooks G.A. (2002), *Lactate and glucose interactions during rest and exercise in men: effect of exogenous lactate infusion*, "Journal of Physiology", 544, pp. 963-975.
18. Nilsson J., Csergö S., Gullstrand L., Tveit P., Egil Refsnes P. (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.
19. Robergs R.A., Ghiasvand F., Parker D. (2004), *Biochemistry of exercise-induced metabolic acidosis*, "American Journal of Physiology", Regulatory Integrative and Comparative Physiology, 287, pp. 502-516.
20. Sekulić D., Metikoš D. (2007), *Osnove trnsformacijskiha postupaka u kineziologiji* [Transformation Procedures in

Kinesiology - Basics. In Croatian] Sveučilište u Splitu, part 1, p. 27.
21. Sterkowicz S., Rukasz W. (1998), *Analysis of the Training of workload plan for judo competitors*, Judo Information Site copyright © 1995/2011. http://judoinfo.com/research8.htm
22. Utter C.A., O'bryant S.H., Haff G.G., Trone A.G. (2002), *Physiological Profile of an Elite Freestyle Wrestler Preparing for Competition*, "Journal of Strength and Conditioning Research" 16(2), pp. 308-315
23. Van Hall G., Jensen-Urstad M., Rosdahl H., Holmberg H.C., Saltin B. (2003), *Leg and arm lactate and substrate kinetics during exercise*, "American Journal of Physiology Endocrinology and Metabolism" 284: 193-205.
24. Yoon (2002), *Physiological Profiles of Elite Senior Wrestlers,* "Sports Medicine", 32, pp. 225-233.

Extended abstract

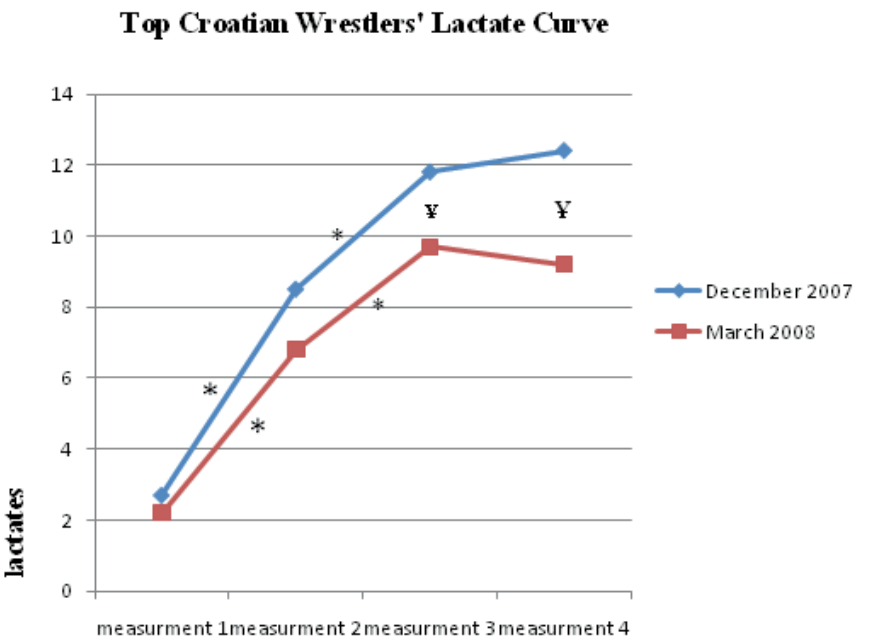
Comparison of lactate curves in a wrestling match at the beginning and the end of competition period for elite croatian greco-roman wrestlers

Hrvoje Karninčić, Mario Baić, Hrvoje Sertić

During the wrestling match oxidative processes continuously alternate between anaerobic and aerobic, depending on the intensity of the match and the working regime. In a large number of sports trend of increased intensity is evident. This trend increasingly pushes the sport in anaerobic zone and accordingly, necessity for control of anaerobic training effects is increasing. National calendar of events is usually created in accordance with the international calendar of events where the most important competition in the season is placed at the end of competition period. For the sport of wrestling, in which anaerobic working regime prevails, it is very important for anaerobic energy capacities to maintain high level till the end of competitive season. The objective of this research was to determine if significant differences exist in measured lactate levels before, during and after the wrestling match, at the beginning and the end of competition period. Second objective was to determine if statistically significant differences occur in the level of measured lactates between the rounds, separately for each period.

Sample of subjects comprised 8 elite Croatian senior wrestlers (national team). Sample of variables comprised lactate samples in wrestling match at the beginning and the end of competition period: before the beginning of the first round and after warming up (Lactates 1 December and Lactates 1 March), after the first round (Lactates 2 December and Lactates 2 March), after the second round (Lactates 3 December and Lactates 3 March) and after the third round (Lactates 4 December and Lactates 4 March). In order to determine differences in measured lactate values ANOVA was used for repeated measurements, in post-hoc analysis Fisher's test was used and results of variables with categorical distribution were additionally tested with non-parametric methods (Friedman's ANOVA).

After warming up, defined in a 15-minutes protocol, control matches were held in accordance with the current international wrestling rules - three two-minutes rounds (rest period between rounds was 30 seconds). Laboratory technicians took blood samples before the first round and after each round. The amount of lactates in blood was determined using Accutrend Lactate device.



Statistically significant difference between two measurements in one test (* p < 0.01, *p< 0.05)
Statistically significant difference in measurements between two tests (¥ p < 0.05, ¥ p< 0.05)

Results showed that lactate curve is significantly lower at the end of competition period after the second round (9.6 ± 1.6 towards 11.8 ± 0.3 being statistically significant at the level of $p<0.05$) and after the third round (9.2 ± 2.1 towards 12.4 ± 0.2 being statistically significant at the level of $p<0.01$). There is an interesting data showing that statistically significant increase of measured blood lactate values was found after the first and the second round while after the third round no statistically significant increase was found for both periods (Fisher $1 < 2 < 3 = 4$). This curve responds to the higher quality wrestlers while with the lower quality wrestlers statistically significant increase of blood lactate values was found only after the first round. We can conclude that, regardless of the fact that wrestlers demonstrated significant decrease in anaerobic capacity after competition period, they were still able to distribute energy throughout the match but they weren't able to maintain high intensity of the match. This research points out the need for correction of the training plan in competition period in order to improve anaerobic capacity so that wrestlers could have on their disposal the maximum of their capacities at the most important competitions.

Porównanie wykresu wartości krzywej mleczanu w czasie zawodów zapaśniczych na początku i końcu zawodów wśród chorwackiej elity zapaśników stylu klasycznego

Słowa kluczowe: fizjologia, wydolność anaerobowa, sport walki, seniorzy

Streszczenie

Podczas walk zapaśniczych następują na przemian beztlenowe i tlenowe procesy utleniania się, w zależności od intensywności zawodów oraz reżimu pracy. W wielu sportach widoczny jest trend zwiększonej intensywności. Trend ten w coraz większym stopniu przesuwa sport w strefę beztlenową, a zatem zwiększa się konieczność kontroli efektów treningów beztlenowych. Kalendarz krajowych imprez jest zazwyczaj tworzony zgodnie z międzynarodowym kalendarzem wydarzeń, gdzie najważniejsze rozgrywki w sezonie są umieszczone pod koniec okresu zawodów. Dla zapasów, w których przeważa beztlenowy reżim pracy, jest bardzo ważne dla energii o charakterze beztlenowym utrzymanie wysokiego poziomu do końca sezonu konkurencji. Celem badań było ustalenie, czy istnieją znaczne różnice w mierzonych poziomach mleczanu przed, podczas i po zawodach zapaśniczych, na początku i na końcu okresu zawodów. Drugim celem było ustalenie, czy występują statystycznie istotne różnice w poziomie mierzonych mleczanów pomiędzy rundami, oddzielnie dla każdego okresu. Grupa próbna składała się z 8 najlepszych chorwackich zapaśników seniorów (reprezentacja kraju). Zmienne składały się z próbek mleczanu zmierzonych w czasie zawodów zapaśniczych na ich początku i na końcu: przed rozpoczęciem pierwszej rundy i po rozgrzewce (mleczany 1 grudnia oraz mleczany 1 marca), po pierwszej rundzie (mleczany 2 grudnia i mleczany 2 marca), po drugiej rundzie (mleczany 3 grudnia i mleczany 3 marca) oraz po trzeciej rundzie (mleczany 4 grudnia i mleczany 4 marca). W celu określenia różnic mierzonych wartości mleczanu użyto analizy wariacji ANOVA dla powtarzanych pomiarów, a w analizie post-hoc użyto testu Fishera oraz wyniki zmiennych z dystrybucją kategorialną zostały dodatkowo przetestowane przy użyciu nie-parametrycznych metod (np. ANOVA Friedmana).

Po 15 minutowej rozgrzewce wg określonego protokołu mecze kontrolne były przeprowadzone zgodnie z obowiązującymi przepisami międzynarodowymi zapasów tzn. trzy dwuminutowe rundy (okres odpoczynku między rundami wynosił 30 sekund). Technicy laboratoryjni pobrali próbki krwi przed pierwszą rundą i po każdej rundzie. Ilość mleczanów we krwi określono za pomocą urządzenia pomiarowego Accutrend Lactate.