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Original research article

LACTATE AND GLUCOSE DYNAMICS DURING A WRESTLING MATCH - DIFFERENCES BETWEEN BOYS, CADETS AND JUNIORS

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Abstract. *The aim of this study was to establish the differences in lactate and glucose wrestling fight levels for the age categories of boys, cadets and juniors. Also, the aim was to explain lactate and glucose curves and adaptive changes caused by training. The study was conducted on a sample of 30 young wrestlers. The sample was divided into three age categories: boys n=10, cadets n=10 and juniors n=10. Every participant wrestled one match according to the FILA rules. Capillary blood samples were taken for the analysis of blood lactate and glucose before the fight, after each round and after 5 minutes of sedentary rest. The results confirmed that there are no significant differences in blood lactate and glucose dynamics between cadets and juniors. Furthermore, boys have a statistically different lactate level after the first, the second and the third round (p<0,01) than cadets and juniors. Boys also have a statistically different glucose level after 5 minutes of sedentary rest (p<0,001). Lactate dynamics and also glucose dynamics lead to the same conclusion: the best age to start with anaerobic diagnostics through lactate and glucose dynamics is the cadet age.*

Key words: *physiology, age, combat sport.*

INTRODUCTION

Wrestling is a part of poly-structural acyclic sports. Wrestling matches occur in the zone of maximal and submaximal load. The energetics of wrestling is very complex, and anaerobic glycolytic pathways prevail during a fight, for sudden, explosive throws or lifting anaerobic a lactic system (CP - creatine phosphate) produces ATP at a very high

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rate. During breaks, inside or between rounds, the body produces energy through aerobic pathways (Hubner-Wozniak, Kosmol, Lutoslawska, & Bem, 2004). During a match, all the systems operate simultaneously to different degrees, depending on the energy demands placed on the body. Special attention in wrestlers' fitness diagnostics should be placed on the anaerobic lactic energy system. The common tests of anaerobic fitness (Wingate, Margaria, the Shuttle run, etc.) are designed for some other sports. They differ from the wrestling match in their structure, duration, workload, muscle engagement, and even physiological response (López-Gullón, Muriel, Torres-Bonete, Izquierdo, & García-Pallarés, 2011). Anaerobic fitness diagnostics should be done through objective physiological parameters such as blood lactate (Yoon, 2002). It is believed that lactates cause acidosis during intense exercise and the subsequent muscle 'burn' that accompanies vigorous exertion. However, the lactate role is much more complex (Brooks, 2009). Lactate is a highly dynamic metabolite and an important energy source during exercise (Cruz et al., 2012). Recent studies are trying to estimate aerobic/anaerobic fitness states through blood glucose level (Simoes et al., 2010; Sotero, Pardono, Landwehr, Campbell, & Simoes, 2009). The extreme workload during a wrestling match increases blood lactate to 15 mml/L, sometimes even 20 mml/L (Kraemer et al., 2001). Wrestling matches cause hyperglycemia because wrestling is a short term sport of high intensity that raises glucose to a higher level (Kjaer, Kiens, Hargreaves, & Richter, 1991). Big changes of these metabolites make anaerobic diagnostics in wrestling possible (Karninčić, Tocilj, Uljević, & Erceg, 2009). Anaerobic energy pathways in humans evolve through puberty and before puberty, while aging causes a decline of the anaerobic capacity which is significant at the age of 70 (Korhonen, Suominen, & Mero, 2005). Age difference may cause lactate and glucose dynamics differences in a wrestling match, as well as over a longer period of anaerobic training. Training affects glucose metabolism and creates adaptive changes (Friedlander, Casazza, Horning, Huie, & Brooks, 1997; Kjaer, et al., 1991). Therefore, differences in lactate/glucose dynamics between the wrestlers of different age categories can be expected. Boys begin wrestling at the age of 10 and by the age of 18 they pass through three age categories (boys, cadets, juniors). There are no lactate or glucose reference ranges for age categories of boys and cadets, even for juniors there are few reports of lactate levels in wrestling matches. There are no reports on when to start with physiological testing, whether the reason is the maturation of anaerobic metabolism or anaerobic training adaptive changes. The study aim is to establish differences in lactate and glucose wrestling fight levels for the age categories of boys, cadets and juniors, as well as to explain lactate and glucose curves and their training-induced adaptive changes.

THE METHOD

The sample of participants

The study was conducted on a sample of 30 young wrestlers. The sample was divided into three age categories: boys n=10, cadets n=10 and juniors n=10 (age categories according to the international FILA wrestling rules). All of the participants were members of wrestling clubs all over Croatia and they participated in the Croatian Greco-Roman wrestling championship ranking from first to tenth place. The participants took part in the study voluntarily, with a written informed consent signed by each parent prior to the commencement. The ethical committee of the Faculty of Kinesiology in Split approved the study protocol.

Table 1. Descriptive statistics (Mean ± SD) of physical characteristics, wrestling experience and placement on the national championship.

	Boys		Cadets		Juniors	
	Mean±SD	Min/Max	Mean±SD	Min/Max	Mean±SD	Min/Max
Age	12.7 ± 0.5	12.0 / 13.0	15.6 ± 0.5	15.0 / 16.0	18.2 ± 1.1	17.0 / 20.0
Experience	2.1 ± 0.7	1.0 / 2.6	5.2 ± 2.2	2.0 / 10.0	6.5 ± 3.2	1.0 / 12.0
Body mass	59.9 ± 13.2	44.0 / 79.0	72.3 ± 13.1	55.0 / 96.0	71.4 ± 12.3	55.0 / 93.0
Body height	1.7 ± 0.1	1.6 / 1.8	174.6 ± 6.9	161.0 /182.0	174.6 ± 6.4	160.0 / 183.0
BMI	20.7 ± 3.4	16.2 / 26.1	23.6 ± 3.1	19.8 / 29.8	23.3 ± 2.8	19.0 / 27.8
Ranking	3.4 ± 1.1	2.0 / 5.0	3.8 ± 2.5	1.0 / 7.0	4.0 ± 3.1	1.0 / 9.0

Variables

The sample of variables included 10 physiological variables: (1 – lactate level before the match – after the warm-up, 2 – lactate level after the first bout, 3 – lactate level after the second bout, 4 – lactate level after the third bout, 5 – lactate level after 5 minutes rest, 6 – glucose level before the match – after the warm-up, 7 – glucose level after the first bout, 8 – glucose level after the second bout, 9 – glucose level after the third bout, 10 – glucose level after 5 minutes rest). Heart rate was recorded as a measure of match intensity.

Protocol

The participants were instructed to avoid any medication, caffeine, and alcohol, as well as to avoid vigorous exercise within 24 hours before the test. Testing started at 10:00 a.m. A warm-up protocol of 15 minutes included: 5 minutes of running, 5 minutes of general preparatory exercises, and 5 minutes of specific pair exercises. Every participant wrestled one match according the FILA rules (3×2 minutes). An exception to the rule was match duration, (the participants wrestled till the time expired, without fall or technical superiority stoppage). Capillary blood samples obtained by a finger prick were collected for analysis of blood lactate and glucose before the fight, after the each round, and after 5 minutes of sedentary rest. Laboratory technicians collected the blood samples.

Measuring equipment

An accoutered lactate portable analyzer was used for lactate level measurement, while Baldari established the validity (Baldari et al., 2009; Freckmann et al., 2010). An Accu-Chek Active analyzer was used for glucose level measurement, while Freckmann established the validity (Freckmann et al., 2010). Heart rate was measured by Polar PE3000 Heart Rate monitor (Polar Electro Oy, Kempele, Finland). Body mass and body height were measured by a Medical scale and Martin's anthropometry.

Statistical analyses

Statistical data analysis was carried out using the statistical package Statistics version 7.0. (Statsoft, USA). The data were presented as means, standard deviation, sample minimum, and sample maximum. Normal distribution of each variable was checked using the Shapiro and Wilk's test. After the ANOVA for repeated measurements, the Fisher LSD post-hoc test was used to assess the differences in the repeated measures between the age groups and between the measurements inside the groups. Statistical significance was set at *p<0.05*.

RESULTS

Table 2. Shapiro Wilks' test for normality (W parameter, p-value).

	Boys		Cadets		Juniors	
Variables	W	p	W	p	W	p
Lactate 1	0.93	0.48	0.89	0.19	0.97	0.93
Lactate 2	0.92	0.32	0.98	0.96	0.94	0.54
Lactate 3	0.94	0.54	0.96	0.83	0.94	0.54
Lactate 4	0.96	0.83	0.88	0.13	0.94	0.55
Lactate 5	0.92	0.35	0.97	0.88	0.98	0.97
Glucose 1	0.89	0.18	0.95	0.61	0.91	0.27
Glucose 2	0.86	0.07	0.90	0.22	0.96	0.80
Glucose 3	0.93	0.50	0.97	0.93	0.91	0.28
Glucose 4	0.94	0.60	0.94	0.60	0.94	0.55
Glucose 5	0.94	0.51	0.91	0.30	0.86	0.08

p values <0.01 indicating non-normality

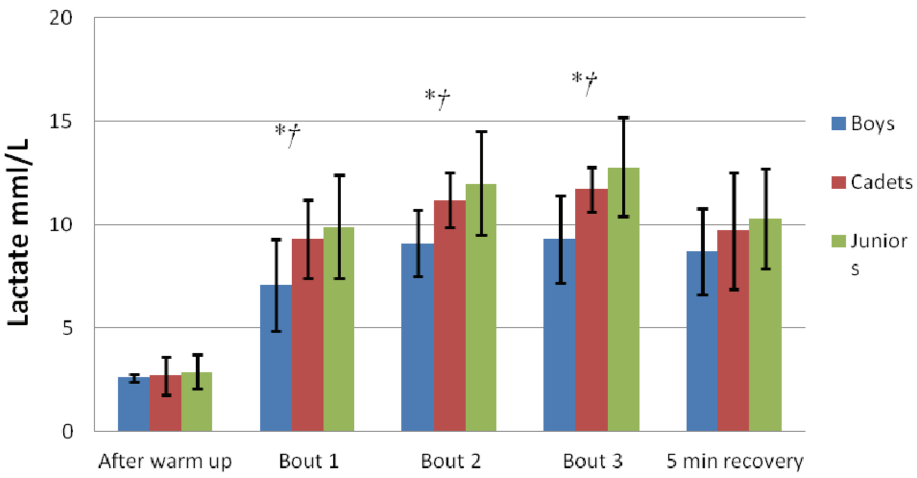
No significant deviations from normality were found after using the Shapiro-Wilks test for normality on the analyzed variables.

Table 3. Descriptive statistics (Mean ± SD) of lactate, glucose and heart rate with differences between the measures inside the age groups (Fisher LSD test).

	Boys		Cadets		Juniors	
	Mean±SD	Min/Max	Mean±SD	Min/Max	Mean±SD	Min/Max
La 1	2.6 ± 0.2	2.3 / 2.9	2.7 ± 0.9	1.8 / 4.6	2.9 ± 0.8	1.5 / 4.0
La 2	7.1 ± 2.2*	3.2 / 9.7	9.3 ± 1.9*	5.9 / 12.7	9.9 ± 2.5*	6.4 / 14.2
La 3	9.1 ± 1.6*	6.1 / 12.1	11.2 ± 1.3*	9.0 / 13.1	12.0 ± 2.5*	7.9 / 15.5
La 4	9.3 ± 2.1	5.2 / 12.2	11.7 ± 1.1	10.5 / 14.1	12.8 ± 2.4	8.9 / 16.4
La 5	8.7 ± 2.1	5.5 / 13.2	9.7 ± 2,8**	4.6 / 14.2	10.3 ± 2.4**	6.3 / 14.7
Gl 1	5.8 ± 1.0	4.7 / 8.1	5.0 ± 1.2	3.0 / 6.7	5.6 ± 0.6	4.4 / 6.2
Gl 2	5.9 ± 0.8	5.0 / 7.3	5.3 ± 1.1	3.6 / 6.6	5.6 ± 0.7	4.7 / 6.8
Gl 3	6.6 ± 1.2	5.2 / 9.0	6.8 ± 0.8*	5.2 / 7.8	6.6 ± 0.7*	5.0 / 7.7
Gl 4	6.8 ± 0.5	6.2 / 7.8	7.7 ± 1.1*	5.4 / 9.3	7.5 ± 1.0*	6.3 / 9.4
Gl 5	7.1 ± 0.8	5.8 / 8.8	8.7 ± 1.5*	7.0 / 11.7	8.0 ± 1.8	6.2 / 11.9
Hr 1	107.5 ± 11.8	95.0 / 128.0	104.6 ± 15.4	80.0 / 126.0	104.8 ± 13.2	90.0 / 132.0
Hr 2	165.1 ± 18.2	135.0 / 185.0	184.3 ± 6.6	175.0 / 195.0	188.1 ± 7.3	175.0 / 200.0
Hr 3	177.0 ± 13.5	151.0 / 194.0	191.0 ± 5.9	183.0 / 201.0	187.6 ± 8.6	175.0 / 206.0
Hr 4	175.9 ± 13.3	150.0 / 195.0	195.4 ± 9.6	184.0 / 214.0	189.3 ± 7.0	180.0 201.0
Hr 5	122.1 ± 8.4	111.0 / 138.0	124.1 ± 6.0	115.0 / 132.0	123.0 ± 9.7	110.0 136.0

La – lactate (mml/L), Gl – Glucose (mml/L), Hr – heart rate (bpm)
* Significant increase at p<0.05, ** significant decrease at p<0.01

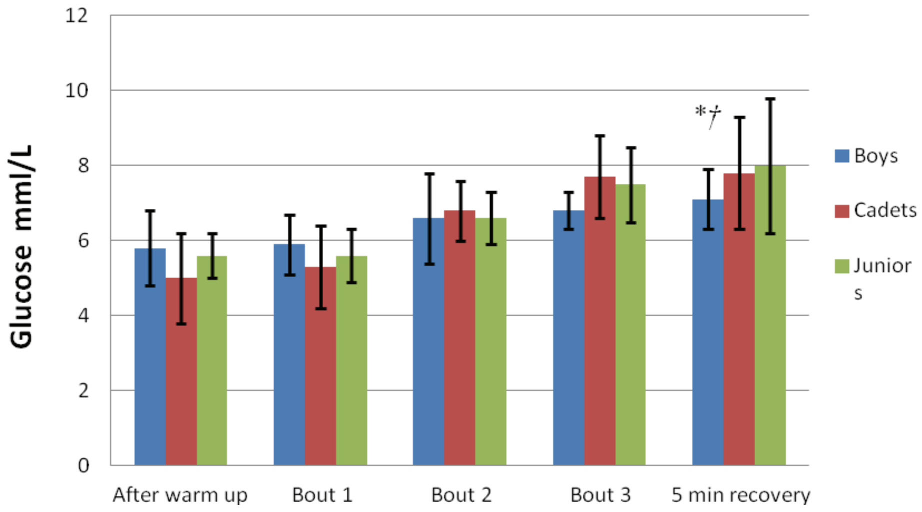
There is a statistically significant increase in the lactate level for all age categories after the first and the second round (*p<0.05*). The lactate level statistically decreased after 5 minutes of sedentary rest for the age category of juniors and cadets (p<0.01). Wrestling match lactate dynamics were established (Fisher LSD): boys 1 < 2 < 3 = 4 = 5, cadets 1 < 2 < 3 = 4 > 5, and juniors 1 < 2 < 3 = 4 > 5. A statistically significant increase in glucose (*p<0.05*) was found after the second round, the third round, and after 5 minutes of sedentary rest for cadets, while juniors showed a significant increase after the second and the third round (*p<0.05*). Wrestling match glucose dynamics in these three age categories was (Fisher LSD): boys 1 = 2 = 3 = 4 = 5, cadets 1 = 2 < 3 < 4 < 5, and juniors 1 = 2 < 3 < 4 = 5.



Graph 1. Lactate curves for boys, cadets and juniors with differences between the groups (Fisher LSD test).
* Differences between the boys and cadets significant at p<0.01
† Differences between the boys and juniors significant at p<0.01

There are no statistically significant differences in lactate levels between cadets and juniors for all measurements, but the boys had a statistically significant lower lactate level from cadets and juniors after the first, the second, and third round (*p<0.01*). The established wrestling fight lactate level differences between the age categories are (Fisher LSD): boys vs. cadets 1 = 1, 2 < 2, 3 < 3, 4 < 4, 5 = 5, boys vs. juniors 1 = 1, 2 < 2, 3 < 3, 4 < 4, 5 = 5, cadets vs. juniors 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 =5.

There were no statistically significant differences in the glucose level between the cadets and juniors in either measurement. The glucose level after 5 minutes of sedentary rest was significantly lower among the boys than the cadets (*p<0.01*) and juniors (*p<0.05*). The established wrestling fight glucose level differences between the age categories are (Fisher LSD): boys vs. cadets 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 < 5, boys vs. juniors 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 < 5, cadets vs. juniors 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 =5.



Graph 2. Glucose curves for boys, cadets and juniors with differences between the groups (Fisher LSD test).
*Differences between the boys and cadets significant at $p<0.01$
† Differences between the boys and juniors significant at $p<0.05$

DISCUSSION

The average heart rate values after each round for cadets and juniors was between 175 and 195 beats per minute, suggesting that the matches were highly competitive and that the intensity and motivation were very high. Previous studies showed heart rate values between 175 and 188 beats per minute after the wrestling match, for the sample of seniors (Barbas et al., 2011; Kraemer et al., 2001). Boys' heart rate values were significantly lower (165 to 177 beats per minute). It can be concluded that either the intensity and motivation were lower, or they miscalculated their energy reserves and burnt out before the end of the round when the heart rate was recorded. We can assume that the lack of experience in that age could be the reason why they had no ability to distribute energy throughout the round. Anaerobic capacity diagnostics through blood lactate measurement in wrestling is never done on a sample of boys and cadets, but there are few reports of wrestling lactate measurement on a sample of juniors. Boys, cadets, and juniors significantly increased their lactate level after the first and the second round - that is a high quality wrestler characteristic (Karninčić et al., 2009). The boys' lactate level is significantly lower after the first, the second, and the third round. Anaerobic capacity development begins in pre-puberty. In that period the physiological development can be a reason for the abovementioned differences although there are significant differences between the boys' and cadet/juniors' training habits. Cadets have 3 and juniors 4.5 years of wrestling experience more than the boys (Table 1). But the quantity of training is not the only difference between the boys and the others. During the first few years, beginners are in the process of learning wrestling techniques, thus the developments of motor and functional abilities are not of primary interest. This ratio gradually changes in favor of motor and functional abilities. During this period training has no significant influence on the development of the anaerobic performance, as can be seen in the measured physiological parameters. Only elite wrestlers can wrestle a match of extremely high intensity. That intensity increases the lactate level. Therefore, a low level of lactates (in the match) means that the wrestler is out of shape. At the end of the competition period, anaerobic capacity is seriously disturbed during the competitive season and lactate curve is significantly lower (Karninčić, Baić, & Sertić, 2011). There are no statistically significant differences in lactate levels between cadets and juniors for all measurements. Juniors have 1.3 years more experience but cadets have better ranking on national championships by 0.2 places. After 5 minutes of sedentary rest, the lactate level significantly decreased ($p<0.01$) for cadets and juniors, but not for boys. The lactate oxidation rate depends on the anaerobic fitness level. It can be concluded that the recovery is much slower for boys, while the anaerobic adaptive changes are yet to happen at their age. As boys do not have sufficient energy supplies for the entire round they cannot raise the lactate level and they have a slow recovery. Based on this study, it can be concluded that one should not start with anaerobic capacity diagnostics, through blood lactate measuring, before the cadet age. Energy can be extracted from glucose or from molecules more complex than glucose. Molecules such as proteins, carbohydrates and fats can be broken down into monomers and enter glycolysis or the citric acid cycle. Still, glucose is the main body energy source. Some glucose goes to the bloodstream while the rest is stored in the liver and muscles in the form of glycogen. In comparison to the boys, the cadets and juniors showed a lower but not statistically significant level of blood glucose before the fight. Training reduces the rate of glucose appearance (Mendenhall, Swanson, Habash, & Coggan, 1994); well-trained athletes have a lower rate of rest glucose, but during anaerobic exercise they have a higher rate of glucose appearance than untrained people. Muscle anaerobic glycolysis depends on muscle glycogen rather than on blood glucose (Palleschi, Mascini, Bernardi, & Zeppilli, 1990); hyperglycemia, in trained athletes during intense exercise, appears to be due to this lower rate of glucose utilization rather than a higher rate of glucose production (Coggan, Raguso, Williams, Sidossis, & Gastaldelli, 1995). A well-trained wrestler has large glycogen reserves that his muscles use during high intensity exercise for energy production. Glucose released from the liver gets accumulated in the bloodstream. Juniors and cadets have a higher rate of glucose appearance than boys in all measurements - in the last measurement (after 5 minutes of sedentary rest) the difference was statistically significant ($p<0.01$). These results fully coincide with the research of glucose kinetics during high-intensity exercise (Coggan et al., 1995; Palleschi et al., 1990). After a high intensity exercise, well trained athletes have a higher level of blood glucose as well as a higher level of protein GLUT 4 (Kristiansen, Gade, Wojtaszewski, Kiens, & Richter, 2000). Therefore, it can be assumed that a well-trained wrestler, who has a higher level of blood glucose and a higher amount of GLUT 4 protein has faster muscle glycogen resynthesis. Also, a well-trained wrestler, who has a higher level of blood glucose and a higher amount of GLUT 4 protein, has faster muscle glycogen resynthesis. Wrestlers have the ability of faster muscle glycogen resynthesis after rapid weight loss (Tarnopolsky et al., 1996). A higher level of glucose in recovery is a training-indicated adaptive change. This change allows wrestlers a faster muscle glycogen resynthesis, and full recovery for the next match.

CONCLUSION

The aim of this study was to establish the differences in lactate and glucose wrestling fight levels for the age categories of boys, cadets, and juniors. The results confirmed that there are no significant differences in blood lactate and glucose dynamics between cadets and juniors. Furthermore, boys have statistically different lactate and glucose dynamics than cadets and juniors. The reason for these differences is the absence of training-indicated adaptive changes in boys. Lactate and glucose dynamics have led us to the same conclusion: the best age to start with an anaerobic diagnostics through lactate and glucose dynamics is the cadet age.

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DINAMIKA POTROŠNJE LAKTOZE I GLUKOZE TOKOM RVANJA – RAZLIKE IZMEĐU MLAĐIH KATEGORIJA, KADETA I JUNIORA

Hrvoje Karninčić, Toni Gamulin, Mirsad Nurkić

Cilj ovog istraživanja bio je da se odrede razlike u laktozi i glukozi tokom rvanja za uzrasne kategorije mlađih rvača, kadeta i junior. Takođe, cilj je bio da se objasne krive laktoze i glukoze i adaptivnih promena koje su posledica treninga. Istraživanje je sprovedeno na uzorku od 30 mlađih rvača. Uzorak je podeljen na tri starosne kateogrije: mlađe dečake n=10, kadete n=10 i juniore n=10. Svaki ispitanik je učestvovao u jednom meču u skladu sa pravilima FILA. Uzorci kapilarne krvi uzeti su od učesnika radi analize laktoze i glukoze u krvi pre meča, nakon svake rudne i pet minuta nakon mirovanja. Rezultati su potvrdili da nije bilo statistički značajnih razlika u pogledu dinamike laktoze i glukoze u krvi između kadeta i juniora. Dalje, mlađi dečaci imaju statistički značajne razlike u nivou laktoze nakon prve, druge i treće runde (p<0,01) u odnosu na kadete i juniore. Mlađi dečaci takođe imaju statistički značajne razlike u nivou glukoze nakon petominutnog odmora (p<0,001). Dinamika laktoze i glukoze dovodi do istog zaključka: najpogodnije godine za početak anaerobne dijagnostike putem laktoze i glukoze je uzrasat kadeta.

Ključne reči: *fiziologija, uzrast, borbeni sport.*