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Original research article

LACTATE CONCENTRATION IN GRECO-ROMAN WRESTLERS BEFORE AND AFTER FINAL MATCHES

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Abstract. *The aim of the study was to determine and compare blood lactate levels by the round in which the senior wrestler ended the match in an official national Greco-Roman wrestling competition.*

The study was carried out on a sample of 20 male wrestlers, finalists of the national competition of Serbia. They were divided into three groups according to the round in which the athlete won the match: G1=8, G2=6 and G3=6. Lactate assessment was provided at two points; after the warm-up, and three minutes after the final match ended. The two-way ANOVA and Fisher's LSD statistic were used in order to compare the differences between the three groups (wrestlers who won after the first, second or third round). The level of statistical significance was set at 0.05.

The results of the lactate values reported for the three groups of wrestlers after the warm-up was similar, whereas, after the match, the wrestlers who won after the third round showed significantly higher lactate levels compared to athletes who won after the first (7,45 mmol/L; $p<0,001$) or second round (4,48 mmol/L; $p=0,014$). The lactate values of wrestlers that won after the first or second round were close to significance (2,97mmol/L; $p=0,06$).

Wrestlers that won their match after the third round accumulated higher lactate levels compared to those who won after the first or second round, indicating that these athletes seem to be trained to work at high intensity.

Key words: *wrestling match, elite athletes, competition*

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INTRODUCTION

A competitive wrestling match consists of high-intensity efforts alternating with brief, mild to moderate intensity work. The periodic rule changes in the scoring system and match duration modify the physiological demands of wrestlers for sport performance and success (Yoon, 2002). A wrestling match consisted of three rounds. Each round lasts 2 minutes, with a 30-second pause in between. These kind of rule modifications consequently reveal that modern wrestling increased the anaerobic energy system use, and it elevates the wrestlers' heart rates to a maximal level (Kreamer et al., 2001) with moderate to high lactate concentrations (10-20 mmol·L⁻¹) following competition (Kreamer et al., 2001; Nilsson, Csörgö, Gullstrand, Tveit, & Refsnes, 2002; Karninčić, 2013). By observing the intensity of the wrestling match, it is obvious that the anaerobic component is of vital importance. Accordingly, Gierczuk & Dlugolecka (2009) reported that during a wrestling match, the ratio of the lactic to alactic anaerobic processes is 1:9. Maximal and sub-maximal loads inter change within the wrestling match, indicating that the anaerobic glycolytic pathway is the main source of energy, since only 2 minutes of wrestling increases blood lactate levels up to 8.6 mmol/L-11.8 mmol/L, as reported by Karninčić, Tocilj, Uljević & Erceg (2009).

Measurements of blood lactate levels have been used for many years in sport diagnostics. These measurements represent an integral part of tests for anaerobic threshold determination and speed of lactate oxidation during the recovery of athletes (Karninčić, 2013). Blood lactate concentrations have been extensively examined during martial arts competitions, since in anaerobic exertions that parameter is informative in evaluating the contribution of energy derived from glycolysis (Loupos, Tsalis, Papadopoulos, Mathas & Mougios, 2008; Obmiński, Lerczak, Witek & Pintera, 2010). Furthermore, the blood lactate level of athletes during intense training or competition has been used as an indicator of anaerobic power and capacity in successful wrestlers (Yoon, 2002), as well as for assessing levels of acidosis in working muscles, and muscle fatigue (Karninčić et al., 2009; Karninčić, Baić & Sertić, 2011).

In the past, some studies (Spencer & Katz, 1991, Westerblad, Allen & Lännergren, 2002) showed that lactate accumulation coincides with an increased acidity of the blood and working muscles. However, in the review of Robergs, Ghiasvand & Parker (2004) it is stated that there is no biochemical support for lactate production causing acidosis, in addition to the claim that lactates are very useful carbohydrates in times of increased energy demands (Miller et al., 2002).

Even though there were some studies on lactate dynamics in wrestlers during simulated matches (Barbas et al., 2011), the Wingate arm-crank test (Lopez-Gullon et al., 2011), and cycle ergo meter (Baker et al., 2012), still relatively little is known about the lactate profile and dynamics during a wrestling competition. Therefore, the aim of the study was to determine and compare blood lactate levels by the round in which the senior wrestler ended the match in an official national Greco-Roman wrestling competition.

THE METHOD

The sample of participants

This study analyzed blood lactate levels after a real competition in 20 male senior wrestlers. The lactate levels were compared by match duration, so data was divided into three groups according to the round in which the athlete won the match. Wrestling matches consist of three rounds of 2 minutes with a 30-second break between rounds, according to FILA rules. The first group of participants included wrestlers who ended their final match by winning after the first round (1x2 minutes) (N=8), the second group included wrestlers who ended their match by winning after the second round (2x2minutes) (N=6), and the third group included wrestlers who ended their match by winning after a full three rounds (3x2 minutes) (N=6). All of the wrestlers won the match after the end of the regular time for each round, and not by pin (win by fall) or 6-point advantage (win by technical superiority), without exception.

Measures

Experienced medical technicians collected blood samples for the lactate assessment at two moments: immediately before the final match (after the warm-up), and three minutes after the end of the match. Samples were collected each time from a different earlobe. Lactate concentrations were determined using the Lactate Pro Blood test meter (Arkray, Inc.). The present study was performed during the Greco-Roman wrestling team championship of Serbia.

Height and weight measurements were taken prior to the beginning of the competition. The height of the athletes was measured with Martin's anthropometer, for weight measurement we used portable electronic scales (Model SR241SO), while the body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared.

All of the participants were fully informed about the nature and demands of the study which was approved by the University's Ethical Advisory Commission (University of Novi Sad, Serbia) in accordance with the Helsinki Declaration. Prior to the competition, all the competitors were familiarized with the testing protocol and gave their written informed consent.

RESULTS

The basic physical characteristics of wrestlers are presented in Table 1. The results obtained in this study showed statistically significant differences between our three experimental groups in terms of body mass and BMI ($p < 0.01$).

Table 1 Physical characteristics of the wrestlers. The data are presented as mean (\pm SD).

Variables	Group 1 (N=8)	Group 2 (N=6)	Group 3 (N=6)
Age (years)	24.12 \pm 1.64	23.83 \pm 4.62	21.50 \pm 2.88
Body height (m)	181.00 \pm 12.40	184.00 \pm 11.78	170.50 \pm 6.02
Body mass (kg)*	86.00 \pm 23.09	92.83 \pm 20.79	64.33 \pm 10.81
BMI (kg·m ⁻²)*	25.75 \pm 3.68	27.06 \pm 2.97	21.99 \pm 2.06
Training experience (years)	13.75 \pm 2.71	13.66 \pm 5.04	11.50 \pm 2.42

*Significant difference at $P < 0.01$.

Lactate values are described in Table 2. Similar lactate values were reported between the three groups of wrestlers immediately before the match, and after the warm-up. After the match, wrestlers who won after the third round had significantly higher lactate levels compared to athletes who won after the first (7,45 mmol/L; $p < 0,001$) or second round (4,48 mmol/L; $p = 0,014$). The lactates values of wrestlers that won after the first or second round were close to significance (2,97mmol/L; $p = 0,06$).

Table 2 Blood lactate levels between the three groups of wrestlers

	Before	After
Group 1	2.61 (0.20)	8.06 (2.35)
Group 2	2.68 (0.50)	11.10 (2.28)
Group 3	2.65 (0.27)	15.55 (4.05)

DISCUSSION

The results of lactate concentrations obtained in the first measurement (2.6 mmol L^{-1}) can suggest that all three groups of wrestlers had an equally effective pre competition warm-up routine. In this sense, the lactate level before the competition does not seem to be useful in predicting the round in which the wrestler can win. However, the main finding of this research indicates that blood lactate values, three minutes after the official bout, vary based on the number of rounds for ending the competition. Peak blood lactates increased as the wrestlers ended their matches in the higher rounds. This could mean that with more rounds there is an increase in the lactate concentration. This could indicate that a longer duration of the competition implies modifications in physiological demands. It has been confirmed that blood lactate highly increases during a competition tournament, and it may induce significant demands on wrestlers which may adversely affect their performance, especially during the later stages of the tournament (Barbas et al., 2011). However, these findings in blood lactate concentrations might indicate that the group of wrestlers was able to increase lactates gradually throughout the whole match in order to sustain the effort. According to Robergs et al. (2004), the increase in lactate production coincides with cellular acidosis and remains a good indirect marker for cell metabolic conditions that induce metabolic acidosis. If muscles did not produce lactate, acidosis and muscle fatigue would occur more quickly and exercise performance would be severely impaired. Our athletes seem to be trained to work at high intensity, and our maximal lactate level reported 3 min after the final match in official competition was $15.55 \pm 4.05 \text{ mmol L}^{-1}$.

Previous findings of resting lactate level concentrations before warm-up were between 1.7 mmol L^{-1} to 2.3 mmol L^{-1} (Kraemer et al., 2001) and 1.3 and 2.5 mmol L^{-1} (Barbas et al., 2011). These values were slightly lower than the ones obtained in our research. Our measurement was taken after a 20 minute warm-up protocol that caused slightly elevated values between $2.61\text{-}2.68 \text{ mmol L}^{-1}$, presumably due to the aerobic nature of the warm-up. Similar results after the warm-up period were reported by Karminčić et al. (2009) in their research ($2.61\text{-}2.63 \text{ mmol L}^{-1}$). Lactate concentrations after the match, presented in this study seem a bit lower than values reported by Barbas et al. (2011) ($16\text{-}19 \text{ mmol L}^{-1}$), where post-match lactate levels showed marked increase from the first to the fifth match and with Kraemer et al. (2001), where lactate level safter the wrestling match ranged from 17.1 to

20.0 mmol·L⁻¹ in free style wrestlers after a weight reduction. A stress of 6% body weight loss and two day simulated tournament may have tampered with the athletes' abilities to sustain effort and high level of sports performance throughout the competition. On the other hand, our results are in line with the study of Lopez-Gullon (2011) (12.1-14.8 mmol·L⁻¹) for a simulated match. These differences in blood lactate values could be attributed to competitive wrestlers' motivation in real, as opposed to simulated tournaments, or maybe to the different set of FILA competition rules in terms of match duration (3x2 instead of the previous 2x5 min). Most other studies investigated blood lactates in wrestlers during simulated matches and wrestling camps (Karninčić, 2013; Karninčić, Gamulin, & Nurkić, 2013; López-Gullón, Muriel, Torres-Bonete, Izquierdo, & García-Pallarés, 2011), or the arm crank test (García-Pallarés, López-Gullón, Muriel, Díaz & Izquierdo, 2011), whereas the results of this research were recorded during an official national tournament. Nevertheless, similar results of high lactate blood levels were obtained in simulated matches and in competitions suggesting the demanding nature of a wrestling match. On the other hand, results obtained during the Wingate arm-crank tests (López-Gullón et al., 2011) showed significant lower levels of blood lactates, indicating that these results maybe related to the lower muscle mass needed for the Wingate arm-crank tests, as opposed to a greater muscle involvement of the wrestling actions during official competitions, in addition to a shorter duration of the test (30 sec).

To our best knowledge, this was the first study that determined lactate concentrations during a real Greco-Roman competition after the last rule change. Authors wanted to check how the lactate level behaves in different durations of a match. Our study showed significant differences between rounds, demonstrating an increase in blood lactate levels with an increase in the number of rounds (2x2 and 3x2) during a single match. Some further research is needed to get evidence that is more substantial on lactate dynamics during real competitions, including the dynamics of the recovery period in lactate clearance. In addition, some other indicators of anaerobic metabolism such as biochemical markers and heart rate during the match should be included in order to gain more clear insight into anaerobic mechanisms that occur during the match in elite wrestlers.

CONCLUSION

The aim of this research was to investigate if there are differences in blood lactates between wrestlers that have ended their final matches in different rounds. Our findings suggest that wrestlers that won their match after the third round accumulated higher lactate levels compared to those who won after the first or second round. Furthermore, wrestlers were able to raise lactate levels gradually throughout the whole match in order to sustain the effort.

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KONCENTRACIJA LAKTATA PRE I NAKON MEČEVA KOD RVAČA GRČKO-RIMSKIM STILOM

Cilj istraživanja je bio da se utvrdi i uporedi nivo laktata u krvi seniora rvača, u odnosu na rundu u kojoj su završavali svoje finalne mečeve na zvaničnom prvenstvu države u rvanju grčko-rimskim stilom.

Istraživanje je sprovedeno na 20 rvača, finalista državnog prvenstva Srbije. Takmičari su bili podeljeni u tri grupe prema kriterijumu u kojoj rundi su osvojili meč: $G_1 = 8$, $G_2 = 6$ i $G_3 = 6$. Procena laktata se vršila nakon zagrevanja, kao i u trećem minutu nakon završetka meča. Razlike između 3 grupe rvača su utvrđene primenom dvosmerne ANOVE i Fišerovovog LSD testa, dok je statistička značajnost podešena na $p < 0,05$.

Vrednosti laktata dobijenih nakon zagrevanja između 3 grupe rvača su bile slične, dok su vrednosti laktata nakon meča kod rvača koji su osvojili meč posle treće runde pokazali znatno viši nivo laktata u odnosu na rvače koji su osvojili posle prve ($7,45 \text{ mmol/l}$; $p < 0,001$), ili druge runde ($4,48 \text{ mmol/l}$; $p = 0,014$). Blizu statističke značajnosti su se našle vrednosti laktata rvača koji su osvojili meč nakon prve ili druge runde ($2,97 \text{ mmol/l}$; $p = 0,06$).

Rvači koji su finala završavali nakon treće runde su akumulirali i veće vrednosti laktata u krvi u odnosu na rvače koji su finala završili nakon prve ili druge runde, što bi moglo ukazivati na to da su ovi sportisti trenirani na visokointenzivni rad.

Ključne reči: rvački meč, vrhunski sportisti, takmičenje