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Research article

Lactate profile during Greco-Roman wrestling match

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Abstract
The objective of this study was to determine and compare lactate profile of two groups of Greco-Roman wrestlers with different competences and training experience. Study was conducted on 10 wrestles that were members of Croatian national team and 10 wrestlers that were members of Wrestling club Split. Lactate samples were collected at four intervals during control fights that were held according to international wrestling rules of World wrestling federation FILA. Values of lactate increased as competition progressed, and they were highest at the end of the match for both groups of wrestlers. According to this study there were no significant differences in lactate between two groups at the end of the match, while significant differences were noted during the match. The information about lactate profile presented in this study can be used by coaches and wrestlers to develop condition programs.

Key words: Anaerobic, aerobic, energy system, combat sport.

Introduction

A wrestling match is an intermittent physical exercise of variable intensity (Hübner-Woźniak et al., 2006). It is characterized by sudden, explosive attacks and counterattacks that are executed repeatedly (Hübner-Woźniak et al., 2004). In wrestling, as in many other sports, both anaerobic and aerobic energy systems are employed to a various degree (Cinar and Tamer, 1994; Callan et al., 2000). The anaerobic system provides the short, quick bursts of maximal power during the match while the aerobic system contributes to the wrestler's ability to sustain effort for the duration of the match (Callan et al., 2000).

Traditionally, level of lactate in athletes during intense training or competition has been used for assessing level of acidosis and muscle fatigue. However in the recent review of acidosis, Robergs et al. (2004) state that there is no biochemical support for lactate production causing acidosis. According to these authors, increased lactate production coincides with cellular acidosis and remains a good indirect marker for cell metabolic conditions that induce metabolic acidosis. If muscle did not produce lactate, acidosis and muscle fatigue would occur more quickly and exercise performance would be severely impaired.

Although there are many studies on lactate dynamics in different sports, still relatively little is known about lactate profile during a wrestling competition. Published studies on lactate in wrestlers (Cinar and Tamer, 1994; Callan et al., 2000; Kramer et al., 2001; Lutoslawska et al. 1998; Nilsson et al., 2002; Utter et al., 2002; Hübner-Woźniak et al., 2004; 2006) analyze lactate dynamics under experimental conditions, in the beginning and at the end of the match, or only at the end of the match. To our knowledge, there are no data available on lactate dynamics during a wrestling match. Therefore, the objective of this study was to determine and compare lactate profile of two groups of Greco-Roman wrestlers with different competences and training experience.

Methods

Study was conducted on two groups of wrestlers with different competences and training experiences. Group 1 (EW) consisted of 10 wrestles that were members of Croatian national team, while group 2 (CW) consisted of 10 wrestlers that were members of Wrestling club Split. Descriptive data collected included age, body height, body mass, body mass index and years of training. Each subject was familiarized with the experimental procedure and they all gave informed consent to participate in the study.

Sampling of lactate on wrestlers was conducted in March of 2008 in training camp in Split during control fights that were held according to international wrestling rules of World wrestling federation FILA. Each fight consisted of three 2 minutes rounds, with 30 seconds break between each round. Although according to FILA rules, after pin (win by fall) or 6-point advantage (win by technical superiority) winner of the round is proclaimed and the round is stopped, for the purpose of this testing, fight was continued till the end of the round. Similarly, even if wrestler won in two rounds, fight was continued and always lasted full three rounds. Fights took place between wrestlers of same qualities and categories.

Blood samples were collected by experienced medical technicians at four intervals: before the first round (after warm-up), after the first round, after the second round, and after the third round (end of fight). Samples were collected each time from a different finger. Lactate concentrations were determined using Accutrend Lactate Analyzer.

Data are reported using descriptive statistics including mean values and standard deviation. The normality of distribution was assessed with Kolmogorov-Smirnov test. T-test and one way-ANOVA were used for analyzing the differences between groups and measuring times. Tukey test was used for post-hoc comparison. Value of α was set at 0.05 for all analysis. Data were analyzed in Statistica v.7 software.

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Results

Data on age, physical characteristics and training experience of analyzed wresters and given in Table 1. Wrestlers from group 1(EW) and 2 (CW) had similar body height, body mass, and body mass index. Differences observed between two groups were in age and years of experience - wrestlers from group 1 were younger and had more training experience than wrestlers from group 2.

Table 1. Physical characteristics of subjects. Data are mean (±SD).

Variables	EW (N=10)	CW (N=10)
Age (years)	21.0 (1.9)	27.1 (4.2) *
Body height (m)	1.80 (.08)	1.81 (.06)
Body mass (kg)	85.3 (11.8)	85.0 (12.3)
BMI ($kg \cdot m^{-2}$)	26.3 (3.7)	25.9 (2.5)
Training experience (years)	10.5 (1.9)	5.7 (3.0) *

BMI: Body Mass Index; EW: elite level wrestlers; CW: club level wrestlers. * $p < 0.001$

Values of lactate increased as competition progressed, and they were highest at the end of the match for both groups of wrestlers (Table 2).

Discussion

As the lactate is a by-product of anaerobic glycolysis, higher increase in blood lactate concentration in wrestlers indicates that they utilize more anaerobic glycolysis reserves in respect to the aerobic and PCr reserves (Wilmore et al., 2008). Steady state is defined as the highest blood lactate concentration for which the workload is sustainable over time without a continual blood lactate accumulation (Billat et al., 2003). High blood lactate concentrations, well above the steady state (in various sports) indicate that without continuous significant increase in blood lactate concentration, present level of activity is unsustainable which in return forces the wrestler to lower his physical activity and as a consequence his activity in combat.

Recent data (Kraemer et al., 2001; Mahdi, 2007) showed resting state lactate concentrations before warm-up between 1.7 $mmol \cdot L^{-1}$ to 2.3 $mmol \cdot L^{-1}$ which is lower than our first measurement (2.6 $mmol \cdot L^{-1}$). This can be explained by our measuring of lactates after the warm-up. Results of lactate concentrations obtained in first measurement suggest that both groups of wrestlers had equally effective warm-up routine. After the first bout, both the elite and club level wrestlers significantly increased lactate concentrations. Increase in lactate concentrations after the second bout is present in the club and the elite level wrestlers, however only the elite wrestlers show significant increase. At the end of the match the club and the elite wrestlers did not show significant increase in lactate concentrations. Our findings of lactate concentration at the end of the match differ from lactate concentration values reported by (Kraemer et al., 2001). According to these authors lactate concentration at the end of the wrestling match were higher than values reported in this study and they ranged from 17.1 to 20.0 $mmol \cdot L^{-1}$. Observed differences can be attributed to different FILA rules at that time (two bouts, 5 minutes).

Observed differences in lactate concentrations after the first bout between two groups (Table 2) suggest that club wrestlers utilize greater degree energy from anaerobic glycolysis rather than from aerobic energy pathways compared with the elite wrestlers. Even though third bout differences of lactate concentrations between two groups implicated that both groups were unable to sustain level of activity from the previous bouts, elite wrestlers had significant increase in lactate concentration in the first and second bout suggesting that they either have more energy reserves or they utilized it more prudently.

Although lactate concentrations are widely used for approximation of energy derived from anaerobic glycolysis, lactates can not explain energy expenditures of a wrestler during the match. Total energy expenditure in the match can be influenced by two groups of factors: physiological and technical-tactical factors. Physiological factors can be various, including total oxygen consumption (VO_2max), anaerobic threshold, blood and muscle buffer capacity, hemoglobin and myoglobin levels, and economy of effort. Technically-tactical factors include biomechanics of wrestling techniques and tactical planning of combat. The elite wrestlers have more years of experience so it is expected that they are physically better prepared and more proficient in techniques and tactics of wrestling. The more experienced and successful wrestlers are likely to utilize an economy of movement that allows them to exert minimum of energy and optimal force, power or torque in order to score points on the opponent (Horswill, 2000). This could explain differences in energy expenditures and therefore differences lactate profiles during the combat.

Further studies should incorporate more complex physiological variables, such as oxygen consumption (VO_2max), anaerobic threshold, measurement of H+ ions and blood buffering capacity during the combat, as well as morphological characteristics, such as body composition, together with lactate profile in order to gain a further understanding of physiology during a combat situation.

Conclusion

In conclusion, we investigated the differences in match lactate profiles between club and elite level wrestlers. Our findings suggests that less proficient wrestlers (club

Table 2. Blood lactate ($mmol \cdot L^{-1}$) characteristics and lactate kinetics parameters. Data are mean (±SD).

Variables	EW (N=10)	CW (N=10)
Lactate before the fight	2.61 (.58)	2.63 (.51)
Lactate after 1st bout	8.60 (2.15) †	11.83 (2.18) *†
Lactate after 2nd bout	11.82 (1.58) ‡	13.16 (3.23)
Lactate at the end of the fight	12.55 (1.80)	13.23 (1.47)

EW: elite level wrestlers; CW: club level wrestlers; * $p < 0.05$ for differences between groups;
† $p < 0.001$ and significantly different between lactate before fight and lactate after 1st bout;
‡ $p < 0.001$ and significantly different between lactate after 1st bout and lactate after 2nd bout

wrestlers) utilize greater degree energy from anaerobic glycolysis rather than from aerobic energy pathways thus elevating lactate concentrations more quickly compared with more proficient wrestlers (elite wrestlers). There is no difference in lactate concentrations between two groups at the end of the second and third bout. Thus, suggesting that they were unable to sustain their level of activity till the end of the match.

The information about lactate profile presented in this study can be used by as an assessment tool of current wrestling proficiency. Simulating match conditions and measuring lactates, can determine whether wrestler lactate profiles correspond to the club (less proficient) or elite (more proficient) wrestlers. Thus it may be possible to test wrestler's readiness and proficiency without need of more experienced wrestling partners or organizing a real match.

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Key points

- There were no significant differences in lactate concentrations at the end of the match between two proficiency levels of wrestlers.
- More proficient (elite) wrestlers raise lactates gradually through the wrestling match while less proficient (club) wrestlers raise it abruptly at the end of the first bout.
- Both groups of wrestlers are unable to sustain same level of activity through the match suggesting that they are utilizing too much energy from anaerobic glycolysis.

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