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Research article

Determination of judo endurance performance using the *Uchi - Komi* technique and an adapted lactate minimum test

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Abstract

This study aimed to evaluate the viability to use *Uchi-komi* (UK) in the evaluation of the judo endurance performance and using lactate threshold the analysis of the blood lactate ([Lac]) and heart rate (HR) determined through a lactate minimum test. The subjects were a group of 6 male, volunteer judokas, from 25.17 ± 5.76 years old, weight 84.50 ± 23.78 kg and height 1.78 ± 0.10 m, competitors of different levels of performance (from regional to international competitions) and match experience of (11 ± 6) years old. Three tests were performed: a) 3000 m dash in track, b) the adapted test of lactate minimum for running and c) for UK, with execution of the blow *ippon-seoi-nague*. No significant difference was evident for the track tests and UK in relation to blood lactate and heart rate ($p > 0.05$) (3.87 ± 0.38 *vs* 4.17 ± 0.54 mmol·L^{-1} and 167 ± 2 *vs* 152 ± 7 b·min^{-1}, respectively). In conclusion it is stressed that: 1) The specific test for lactate minimum in judo sport is a promising possibility of aerobic capacity evaluation and a instrument of intensity training control; 2) The metabolic profile in V_{lm} and UK_{lm} is similar, because there are not differences in the [Lac] and in the HR at this intensity; 3) It is possible to estimate the training intensity through the determination of the lactate minimum intensity in running (V_{lm}) and the Heart Rate associated (HR) from the execution of *ippon-seoi-nague* (uchi-komi) in judo training; 4) The V_{lm} for judo athletes is approximately 88% of the V_{3000}.

Key words: Judo, lactate threshold, heart rate, test, endurance.

Introduction

Analysis of lactate concentration in specific situations of judo has been reported in order to obtain information on the metabolic demand and implications for training intensities (Jacobs, 1986; Majean and Gaillat, 1986). Endurance training became extremely important to judo, due to inclusion *golden score* at actual rules. According to this scoring process, a match can last 10 minutes and, an athlete can perform more than 9 matches on the same day (Azevedo et al., 2004; Castarlenas and Solé, 1997; Taylor and Brassard, 1981). In the same way, it was showed that judo athletes have low aerobic capacity (see, for example, Drigo et al (1994) and by Franchini et al. (2001) for male judo and female athletes, respectively). Azevedo at al (2004) indicates that the aerobic training for judo athletes is made by running, this training is not specific for the judo sport. As showed by Blais and Trilles (2006) is fundamental form performance increase.

The anaerobic threshold determination from $[Lac]_b$ has been used for the diagnosis of aerobic capacity and to determine exercise intensities for training and scientific investigation (Simões et al., 1999). According to Denadai (2000) terminology and references for anaerobic threshold can be divided in two categories: 1) Thresholds that identifies the beginning of lactate buildup in blood; 2) Thresholds that identifies the maximum stead state of lactate in blood. Both categories field tests can be used to identify sustainable intensity exercise (Simões et al., 2005). As exercise increases above a certain work rate threshold, an anaerobic component of metabolism causes lactate to increase significantly. The threshold at which this begins is termed the anaerobic threshold (Beaver et al., 1986). Tegtbur et al. (1993), proposed a lactate minimum field test to evaluate the aerobic fitness of runners and basketball players. The intensity associated to lactate minimum is identified based on the lowest [Lac] during a incremental test after high [Lac] induction (Simões et al., 2005). Lactate minimum intensity has been considered a valid measure of maximal lactate stead state to be the highest exercise intensity that can be maintained during long term without blood lactate accumulation (Bacon and Kern, 1999; Ribeiro et al., 2003). By our knowledge there are no studies with applied test of determination lactate minimum in judo specific situation.

Taylor and Brassard (1981) state that limited information about physical and physiological characteristics of judo athletes are found in the literature. The Despite its worldwide popularity judo specific research is still limited. After 20 years, the situation is the same because it is hard to describe a single physiological model of judo athletes due to the large number of variables, such as: a) difficulty of quantifying the effort during a match; b) weight categories; c) non-cyclic character; match time can vary from some seconds to ten minutes; d) several matches on the same day; e) difference on physical and technical skills of the opponents (Castarlenas and Solé, 1997; Majean et al., 1986; Silva, 1988).

Castarlenas and Solé (1997), suggest that physical preparation should not be different from everyday training with specific movements or match. Training should be based on combining sport specific technical and physical activities (Azevedo et al., 2004). However, there are few specific tests in judo that can evaluate the physical strength and endurance during a match and these tests are not widely advertised (Carvalho, 2000). Thus, studies are

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not so deeply developed because evaluations taken from other sports do not reproduce specifically the intermittent timing, non-cyclic movement, muscular groups involved, and metabolic demand with large production of lactate that occur during training and competition of judo.

Little (1991) suggests that successful judo performance is dependent upon the player having a high technical and tactical ability, power, strength, endurance and flexibility. Therefore, this study aimed to create a test to evaluate physical fitness in judo and compares results of this lactate minimum test adapted to judo with running (*Gold Standard*), given that endurance training improves the muscular capacity of lactate use (Bonen et al., 2000; Hamann et al., 2001) and increases its transportation through the membrane via increase of monocarboxilate transporter (MCT 1 and 4) (Bonen et al., 2000; Green et al., 2002). This physiological change helps the intramuscular pH stability by retire H^+ ions and retarded the fatigue (Poole and Halestrap, 1993).

Methods

Subjects

A group of 6 male judokas volunteered to participate in the study after being fully informed of the test requirements. Subjects are 25.17 ± 5.76 years old (means ± SD), weight 84.50 ± 23.78 kg and height 1.78 ± 0.10 m, competitors of different levels of performance (from regional to international competitions) and match experience of (11 ± 6) years old was utilized. All subjects had more than 4 years experience with 5 subjects as black belt and 1 as purple belt. All of the subjects were advised not to have any extenuating physical practice 48 hours before the tests.

Procedures

The study was approved by the Human Research Ethics Committee of Federal University of São Carlos, as is required, before obtaining written consent from the participants. After having signed an informed consent form, the athletes performed 3 tests. Each test session began with the participant performing his usual warm-up routine. The first test was a 3000 m time trial (V_{3000}). The orders of the next 2 sessions were randomized and involved a lactate minimum velocity (V_{lm}) and a lactate minimum uchi-komi (UK_{lm}). The heart rate (HR) was monitored continuously during all tests using a Polar Accurex Plus (Kempele, Finland).

The 3000 m velocity test (V_{3000})

V_{3000} was calculated as the mean velocity over 3000 m distance. V_{3000} has been associated with running velocity reached of the maximum oxygen uptake (VO_2max) (Silva et al., 2005). The velocities of the incremental stages for V_{lm} test was calculated based on V_{3000}. This test was undertaken on a 400m coal based track with 100m demarcations (Simões et al., 2005).

Lactate minimum velocity identification (V_{lm})

The athletes first performed a maximal 40 s sprint as it was a race in order to induce a high level of blood lactate concentration. Then, after an 8 min of recovery, the athletes performed an incremental running test consisting of 7x800 m bouts at intensities corresponding to 76%, 80%, 84%, 88%, 92%, 96% and 100% of participant's V_{3000}. The running velocity was controlled by sonorous stimulus (beepers) given to participant on specific time intervals. Capillary blood (25 µl) was collected from the earlobe on the 7th min of recovery after 40 s sprint and during 1 min rest after each 800 m stage for [Lac] measurements (YSI 1500 Sport model, OH, USA). A scatter graphic plotting [Lac] response in relation to running velocities during test was elaborated for each participant. The [Lac] response curve was fitted to identify the lowest blood lactate during test (Figure 1). The running velocity associated with the lowest [Lac] identified the V_{lm} as described previously (Simões et al., 2005; Tegtbur et al. 1993).

Lactate minimum intensities for judo (UK_{lm})

The athletes first performed a maximal 40 s uchi-komi (classical drill training involves little or no movement contrary to the requirements of competition) practicing technique of *ippon-seoi* (is one of the twenty throwing techniques in the Nage No Te list). Then, after an 8 min of recovery, the athletes performed an incremental uchi-komi test consisting of 8x1 min bouts at intensities corresponding to 8 s, 7 s, 6 s, 5 s, 4 s, 3 s, 2 s, 1 s each drills. The uchi-komi intensities was controlled by sonorous

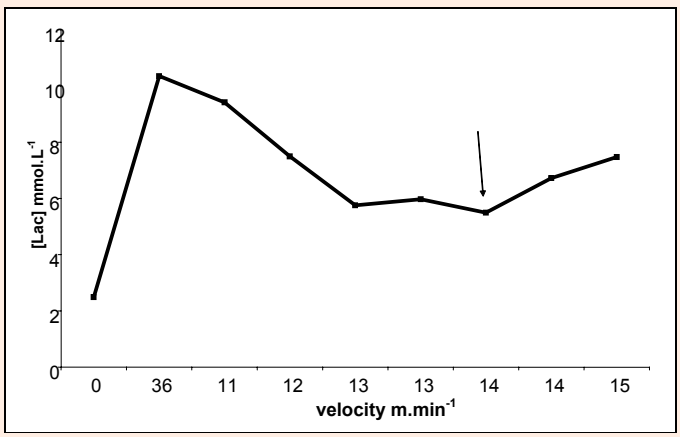

Figure 1. Determination of V_{lm} on the track from 7 x 800-m periods of progressive exercise for a single judo player.

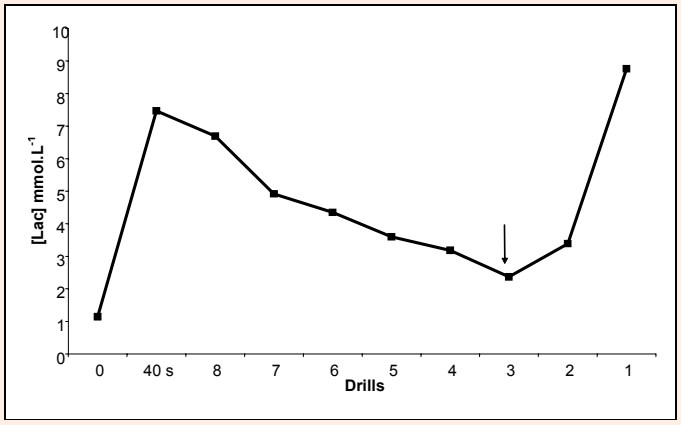

Figure 2. Determination of UK_{lm} on the track from 8 x 1-min bouts of progressive specific judo exercise (uchi-komi) for a single judo player.

stimulus (beepers) given to participant on specific time intervals. Capillary blood (25 µl) was collected from the earlobe on the 7th min of recovery after 40 s maximal UK and during 1 min rest after each 1 min stage for [Lac] measurements (YSI 1500 Sport model, OH, USA). A scatter graphic plotting [Lac] response in relation to uchi-komi intensities during test was elaborated for each participant. The [Lac] response curve was fitted to identify the lowest blood lactate during test (Figure 2).

Statistical analysis

The results are expressed in means, SD and SE for the studied variables. Possible differences in blood lactate and Heart Rate between track-tests and judo-tests trials were determined by the Wilcoxon test. Significant differences were established at $p < 0.05$ and the SPSS software, version 13.0 was used for all analyses (Costa Neto, 1995; Siegel, 1956).

Results

The V_{lm} and UK_{lm} results were identified in all participants (Figure 1 and 2). No differences were verified between lowest [Lac] V_{lm} (3.87 ± 0.38 mmol·L^{-1}) and UK_{lm} (4.17 ± 0.54 mmol·L^{-1}) (means ± SE). Also, no differences were verified between HR V_{lm} (167 ± 2 b·min^{-1}) and UK_{lm} (152 ± 7 b.min^{-1}) (means ± SE).

The mean relative intensity of V_{lm} as related V_{3000} (% V_{3000}) was 88.67 ± 2.75% (means ± SD) with mean velocity 180 ± 11.92 m·min^{-1}. The mean of intensity of UK_{lm} was 2.5 ± 0.5 drills·s^{-1}.

Discussion

The mains contributions of the present work are: a) it was showed, in a preliminary form, the possibility of diagnostic and control of the intensity of training for judo athletes from specific techniques and specific physiologic demands; b) there is an indicative that the control of the intensity of UK_{lm} can be made by HR and V_{lm} parameters; c) from judo athletes, the V_{lm} is near 88% from V_{3000}.

For efficient control of training loads and performance, it is necessary to evaluate the athlete at specifics situations, at least similar to judo practice (Viru and Viru, 2003). Searching for a specific evaluation of judo practice, we performed this study with UK utilizing lactate minimum tests, a well-known method for determination of anaerobic threshold, agreed at control and diagnosis of training process (Azevedo et al., 2004, Simões et al., 2005).

Heart rate monitoring is one of the assessments utilized at prescription and assessment of training intensity and physical effort. In addition, it is an inexpensive and accessible kind of evaluation (Lambert et al., 1998; Lucia et al., 2000). During the test for lactate threshold, heart rate monitoring is recorded to obtain correspondent value to the intensity of anaerobic threshold. In this study, no difference was evident among heart rate at V_{lm} (167 ± 2 b·min^{-1}) and UK_{lm} (152 ± 7 b·min^{-1}) ($p > 0.05$). The HR values find in this work are minor than the values obtained in the running tests, i.e, (178 ± 10 b·min^{-1}) from Tegtbur et al. (1993) and (178 ± 11 b·min^{-1}) from Simões et al. (1998). This result is important because indicate that is possible to realize only one test, running or judo specific test, and use HR in both test for control of training intensity.

Data showed there is no difference between V_{lm} and UK_{lm} in relation to values of lactate at the intensity of lactate minimum. This indicates that the metabolic demands in both exercises are similar in the lactate minimum intensity. The difference between the time on running and UK stage exercises do not shows influence the [Lac] in the V_{lm} and UK_{lm}. It was demonstrated by Pardono et al. (2005) that the methodological variations effects have not significant influence on the determination of lactate minimum intensity in the same ergometrics tests. Endurance training in the intensity of anaerobic threshold is important to improve muscular capacity of using lactate. It increases its transport through the membrane, due to increase of monocarboxilate protein type I (MCT1 and MCT4) (Gladden, 2000) and helps the maintenance of intramuscular pH by retire H^+ ions, retarded the fatigue (Poole and Halestrap, 1993).

Drigo et al. (1994) observed judokas aerobic fitness can present some deficit. They performed a study with three different groups (G), all male subjects. At the test of lactate threshold groups showed speed low: G1: 170.8 ± 17.9 $m \cdot min^{-1}$; G2: 159.1 ± 35.5 $m \cdot min^{-1}$; G3: 191.8 ± 23.5 $m \cdot min^{-1}$. The authors concluded the three analyzed groups were not appropriately prepared aerobically and, showed high lactate concentrations, which indicates that judo training provokes metabolic alterations compatible to the need of the match. In the present work, the running mean velocity in the anaerobic threshold was 180.0 ± 11.9 $m \cdot min^{-1}$. This value is similar to the value find by Azevedo et al. (2004), for one international competitive athlete (174 $m \cdot min^{-1}$), and Drigo et al. (1994) by using the fixed concentration methodology (4 $mmol \cdot L^{-1}$). These results confirm the possibility of specific metabolic adaptation for the sport or a low performance transference from judo to running. Castarlenas and Solé (1997), Little (1991) and Taylor and Brassard (1981) found values of $VO_2max.$ at judokas weighting 57.5 ($mL \cdot kg^{-1} \cdot min^{-1}$) average, showing that physical fitness is roughly important to maintain the high intensity of the effort during a match (Franchini et al., 2007), the delay for evidence of high lactate concentration and, faster recovery of the athlete between matches.

Concerning by the UK_{lm}, the mean value is 2.5 $drills \cdot s^{-1}$. This is the first value find by us in the literature for the lactate threshold specifically applied to judo sport. Usually, the training in the lactate threshold is associated with the aerobic performance increase. In this sense, we can suggest that the judo training in the UK_{lm} intensity can increase the aerobic performance. However, deeper analysis is necessary to confirm this possibility. The main advantage of this training method is the possibility of direct transference of the improvement obtained by specific aerobic training to the mach situation, in the same way indicated by Blais and Trilles (2006) with strength training. It is important to stress that a good aerobic capacity is important to maintain the high intensity in the mach (Franchini et al., 2007).

Conclusion

It is important to develop studies on judo physiology. This area is not so explored in literature. In this work is presented a preliminary investigation that permit concludes:

1. The specific test for lactate minimum in judo sport is a promising possibility of aerobic capacity evaluation and a instrument of intensity training control.
2. The metabolic performance in V_{lm} and UK_{lm} is similar, because there are not differences in the [Lac] and in the HR.
3. It is possible to estimate the training intensity through the determination of the lactate minimum intensity in running (V_{lm}) and the Heart Rate associated (HR) from the execution of *ippon-seoi-nague* (uchi-komi) in judo training.
4. The V_{lm} for judo athletes is approximately 88% of the V_{3000}.

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Key points

- The specific test for lactate minimum in judo sport is a promising possibility of aerobic capacity evaluation;
- This is a instrument for intensity training control for judo players;
- The metabolic profile is similar between running and uki-komi (ippon-seoi-nague techniques) at lactate minimum intensity.

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