AEROBIC AND ANAEROBIC THRESHOLD DETERMINED BY SPECIFIC TEST IN JUDO IS NOT CORRELATED WITH GENERAL TEST

AEROBIC AND ANAEROBIC THRESHOLD IN JUDO

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Abstract then the purposes of this study were to compare and correlate the aerobic threshold (TH_{aer}) and anaerobic threshold (TH_{anaer}) measured during a new single judo specific incremental test and Treadmill Test for aerobic demand evaluation. Eight well-trained male competitive judo players (24.3±7.9 years; height of 169.3±6.7cm; fat mass of 12.7±3.9%) performed a maximal incremental specific test for judo mimicking the UchiKomi drills and on treadmill in different days. There was difference between specific and general TH_{aer} (P=0.0006) as well as weak correlation for TH_{aer} (r=0.32; R^2=0.1; P=0.2) and TH_{anaer} (rs=-0.31; R^2=0.1; P=0.12). When correlation was applied with normalized data (percentage of peak load) we observed moderate correlation for TH_{aer} (r=0.76; R^2=0.58; P=0.027), but the same was not observed for TH_{anaer}. We conclude that there is a need of TH_{aer} and TH_{anaer} evaluation through a specific test for Judo.

Keywords: anaerobic threshold, martial art, sport

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1. Introduction

Our group has studied modes to evaluate the aerobic capacity in fighter athletes' through specific tests [1-3]. Recently we validated an incremental test to determine the ventilatory threshold in judo athletes [1]. As Judo is predominantly aerobic, intermittent and has several fights during a day [4], aerobic capacity assessment is important to evaluate the adaptation facing systematic training process and intensity training prescription. It has been suggested that the better aerobic capacity determination is dependent of specificity and validity of utilized test [5-7]. Here we analyzed whether the specific test is correlated with general test. It is expected a weak correlation, pointing out a need of specific evaluation.

The aerobic and anaerobic threshold determination has been held through general protocol in judo athletes [8-10]. However general tests do not mimic the specificity of judo, like Uchikomi drills and hold on kimono sleeves (*judogui*) [10]. Therefore, we believe that specific evaluation is required and general test cannot be used to predict ideal intensity to training and is not sensible to evaluate the athletes' adaptation facing a training programmer.

Then, the aims of this study were: 1- to correlate aerobic and anaerobic threshold determined by specific test (Uchikomi) with that in treadmill (general) test; 2- to compare the relative intensities of thresholds between specific and general tests. Our hypotheses are that there is a weak correlation between tests, and there are not any differences between thresholds relative to peak load.

2. Materials and Methods Subjects

2.1. Participants

Eight well-trained male judo athletes (mean age of 24.2 ± 6.4 years old; height of 168.2 ± 7.0-cm; body mass of 65.4 ± 13.2-kg) participated voluntarily in this study. Four judo athletes competed in national-level tournaments, whereas four other plays in state competitions. The mean time spent on training was 10.5 ± 0.4 hours a week. All participants were textually and verbally informed about the possible intrinsic risks and benefits of the tests, signing a free informed consent. The study was approved by the research ethics committee of the Federal University of São Carlos, Brazil (Human Research Ethics Committee protocol number 257/2006).

2.2 Experimental design

All the subjects performed a specific incremental test mimicking the *Uchikomi* using a cable crossover machine [1] and a running treadmill test. Both tests were performed until exhaustion. The tests were conducted at the same period of the day with a variation of 2 hours and the interval between tests was one week.

Warm-up exercises consisting of specific judo movements were performed for 5 minutes prior to each test. To minimize the learning effect, the judo athletes attended 5-minute *UchiKomi* sessions using a cable crossover machine for 4 non consecutive days [11]. The pace of *Uchikomi* was controlled through loud signs emitted by a metrometer.

2.3 Experimental Procedures

To determine the aerobic and anaerobic threshold, the subjects were submitted to an incremental test (treadmill (general) test) on a treadmill (Movement LX-150) at an inclination of 1% and initial

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velocity of 6 km.h^{-1}, followed by increments of 1 km.h^{-1} with intervals of 3 minutes between stages [12,13].

Measurements of VO_2, VCO_2 and ventilation were carried out throughout each test using a telemetry system (K4b^2, Cosmed, Rome, Italy). Expired gases were measured breath-by-breath and the results were averaged every 15 seconds. Before each test, the system was calibrated using ambient air and a gas of known O_2 and CO_2 concentration according to the manufacturer's instructions (K4 b^2 instruction manual) and subjects remain standing during 5 minutes for data acquisition and normalization. The turbine flow-meter of the K4 b^2 was calibrated using a 3-L syringe.

The aerobic threshold (TH_{aer}) was determined by three ventilatory parameters: 1) first loss in ventilatory linearity; 2) increase in ventilatory equivalent of O_2 (VE/VO_2); 3) increase in the fraction of expired O_2 ($\%FeCO_2$) [14]. The anaerobic threshold (TH_{anaer}) was determined by three ventilatory parameters: 1) second loss in ventilatory linearity; 2) increase in ventilatory equivalent of CO_2 (VE/VCO_2); 3) decrease in the fraction of expired CO_2 ($\%FeCO_2$) [14]. Two experienced scientists evaluated each graph, and in case of discrepancies, the mean of the identified points was used.

Specific Incremental Judo Test:

The test was developed so that *uchikomi* would be applied in association with *ippon-seoi-nague* technique using a cable crossover machine, with kimono sleeves adaptation onto the crossover machine. The validity and reliability of UchiKomi use for anaerobic threshold determination has been demonstrated previously [15]. Warm-up exercises consisted of 5-minutes with specific judo movements. To minimize the learning effect, the judo athletes attended 5-minute *UchiKomi* sessions using a cable crossover machine for 4 non consecutive days [11]. The pace of *Uchikomi* was controlled through loud signs emitted by a metrometer. Initial load was 1.9-kg, increasing 1.2-kg every 3 minutes [16]. The *UchiKomi* movements had a frequency of one *UchiKomi* every 3 seconds [10]. The test was finished when the subject stopped the movement voluntarily due to exhaustion, when the pre-determined frequency was not kept during 3 consecutive *Uchikomi*, or when U*chikomi* was performed out of the technical pattern.

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2.4 Statistical Analysis

Data is presented as mean ±SD. The Shapiro-Wilk test was applied to assess the normality of data. The differences between the relative intensity of specific and general thresholds were analyzed with a paired *t*-test, and Pearson's correlation coefficient. When data was non-parametric the comparison was made by Wilcoxon test and correlation by Spearman. The significant level was set at $P \leq 0.05$.

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3. Results

The overall results (load and velocity) of the parameters studied are shown in Table 1. Aerobic threshold was 7.1±1.7 kg and 7.7±1.2 km.h^{-1} for specific and general tests, respectively; Anaerobic threshold was 10.3±1.9 kg and 10±1.2 km.h^{-1} for specific and general testes, respectively.

Table 1. Relative intensity of aerobic threshold (TH_{aer}) and TH_{anaer} for overall subjects (n = 8) in specific and general tests.

Subject	SpecificTH_{aer} (kg)	SpecificTH_{anaer} (kg)	GeneralTH_{aer} (km.h^{-1})	GeneralTH_{anaer} (km.h^{-1})
1	7.6	11.3	8	9
2	4.3	6.8	7	10
3	6.8	10	7	8
4	9.1	11.3	10	12
5	5.3	9.1	7	10
6	6.8	11.3	6	9
7	6.8	9.1	8	11
8	10	13.6	9	11
Mean	7.1	10.3	7.7	10
SD	1.7	1.9	1.2	1.2

SpecificTH_{aer}: specific aerobic threshold; SpecificTH_{anaer}: specific anaerobic threshold; GeneralTH_{aer}: general aerobic threshold; GeneralTH_{anaer}: general anaerobic threshold.

The relative intensity load at specific aerobic threshold was significantly different compared to general test (P=0.0006) (Table 2) with 56.3±5.7% and 65.8±7.4% of maximum intensity for general and specific tests, respectively. No difference was observed for anaerobic threshold (P=0.2) (Table 2) with 82.6±2.8% and 84.8±4.3% of maximum intensity for general and specific tests, respectively.

Table 2. Relative intensity in percentage of maximum intensity for general and specific tests.

Subject	GeneralTH_{aer} (% max)	GeneralTH_{anaer} (% max)	SpecificTH_{aer} (% max)	SpecificTH_{anaer} (% max)
1	55.7	82.8	72.7	81.8
2	56.6	89.5	58.3	83.3
3	55.3	81.3	70	80
4	66.7	82.8	76.9	92.3
5	46.9	80.5	58.3	83.3
6	50	83.1	54.5	81.8
7	60.2	80.5	66.7	91.7
8	58.8	80.3	69.2	84.6
Mean	56.3	82.6	65.8	84.8
SD	5.7	2.8	7.4	4.3

GeneralTH_{aer}: general aerobic threshold; GeneralTH_{anaer}: general anaerobic threshold; SpecificTH_{aer}: specific aerobic threshold; SpecificTH_{anaer}: specific anaerobic threshold

There were a weak correlation between specific and general aerobic threshold (r=0.32; R^2=0.1; P=0.2), as well as for anaerobic threshold (r=-0.31; R^2=0.1; P=0.12). When correlation was done by relative intensity we observed a moderate correlation for aerobic threshold (r=0.76; R^2=0.58; P=0.027) and weak correlation for anaerobic threshold (rs=-0.29; P=0.48).

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4. Discussion

The main finding was that there was a weak correlation between tests showing us a need to assess the aerobic capacity in judo athletes by mean of a specific test. The relative TH_{aer} and TH_{anaer} were similar to values reported in literature for general tests. But, when compared, TH_{aer} was different between tests.

The aerobic and anaerobic threshold determination through general test (treadmill and cycle-ergometer) was not able to discriminate the judo athletes level [17,18]. Therefore, is compulsory the use of specific test to assess the physical fitness of athletes [7,19]. However, there are few specific tests for judo [7,10,20]. One of them demonstrated the similarity for metabolic and heart rate response between running and Uchikomi on lactate minimum determination [10]. But, it was not validated yet. A weak correlation has been observed when thresholds are assessed in specific and general tests [21,22]. The difference on motor pattern between specific and general tests could explain the weak correlation observed. Therefore, the treadmill and cycle-ergometer tests are not sensitive to specific adaptation arising for judo training.

The ventilatory response and gas exchange during specific incremental test for judo were not known. However the same pattern found in general test was expected, according to another study [10]. It was able to assess the aerobic and anaerobic threshold for all subjects. This innovative methodology will contribute to specific training and evaluation for judo [23,24] and performance improvement as well [8].

The relative aerobic and anaerobic thresholds were similar to those reported for general tests [25-27]. The relative intensity of specific aerobic threshold was higher than aerobic threshold determined on treadmill (65.8±7.4 *vs* 56.3±5.7%; P=0.0006). It shows that the adaptations are specific, so the athlete evaluation must be done in a specific way as well. The same result was not observed for anaerobic threshold. The possible explanation is that this data was non-parametric, then the subjects' number was fewer than expected and the statistic Power was unable to show us difference between specific and widespread tests.

It is suggested that more offensive judo player style has higher anaerobic capacity [23] than defensive judo player which has better aerobic capacity. Then, more defensive judo player could train in intensity between aerobic and anaerobic threshold because they have several fights during the day each one with longer duration. On the other hand offensive athletes could train in intensity above anaerobic threshold because they need faster anaerobic metabolism to ATP resynthesis during the combat.

5. Conclusion

We concluded that there are weak relationships between specific and general tests for aerobic and anaerobic thresholds confirming our first hypothesis. Additionally, our second hypothesis was partially observed because the relative aerobic threshold intensity was different between tests. The ventilatory response pattern and gas exchange during a specific incremental test for judo was similar to those reported in general tests showing us the concurrent validity of a specific test for judo. Therefore, we must assess the thresholds through a specific test in judo instead of through general tests.

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Conflicts of Interest: The authors declare no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the Human Ethics Committee of the Federal University of São Carlos and with the Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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