

# Effect of interval training in the pre-competition phase on aerobic capacity and peak power in judo contestants at high sports skill level

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**Key words:** judo, interval exercise, running speed at the AT threshold, peak power

## Summary

**Introduction.** The aim of the study was to determine the effect of non-specific training stimuli in the form of interval running exercise used during a 5-week training carried out in the pre-competition period on aerobic and anaerobic capacity of judo contestants at high sports skill level.

**Material and methods.** Over twenty five training sessions, 8 judo athletes repeated each time 6 runs at maximum speed (4x14m shuttle run) interspersed with 30-second rest intervals in conditions typical for judo training (barefoot, on a tatami mat). Level of aerobic capacity was determined based on a laboratory exercise test to exhaustion performed on a mechanical treadmill. Level of anaerobic capacity was evaluated based on the results obtained from the Quebec test (10s maximum exercise on cycle ergometer).

**Results and Conclusions.** Comparison between the results obtained during the exercise test to exhaustion and the Quebec test carried out before and after the pre-competition period revealed a statistically significant increase in running speed at the anaerobic threshold (V.AT.), significant increase in mechanical work (J/kg), peak power (W/kg) and elongation of time of maintaining 97.5% peak power in the Quebec test.

## Introduction

A characteristic feature of competitive exercise in judo is sequences of 10 to 30 second attacks and defences interspersed with 10s rests [1], which causes that cyclically repeated exercise with anaerobic and mixed (aerobic/anaerobic) represent the basic energy expenditure in this sport. In single, several-second actions, the major source of energy for the skeletal muscles is creatine phosphate [2]. During actions that take 20-30 s, the energy for muscular contraction is mainly used from the glycolytic system [3]. During a 5-minute judo bout, the essential importance is also from aerobic processes [4]. Assuming that aerobic and anaerobic capacity might affect the result of a competitive judo bout, the aim of the study was to determine the effects of a 5-week training program carried out in the pre-competition period among judo athletes at high sports skill level.

Aim: to evaluate short (ca. 10s) maximum exercise in the form of the running intervals on running speed at the anaerobic threshold (V.AT.) during graded exercise test to exhaustion on a mechanical treadmill and relative mechanical work (J/kg), peak power (W/kg) and time of maintaining 97,5% of peak power in the Quebec test.

## Material and methods

Subjects: 8 judo contestants (adults) at high sports skill level. Mean age of the subjects = 23.8±2.5 years, mean body mass = 85.7±4.7 kg, mean body height = 179.8±5.4 cm, mean competitive experience = 8.3±3.6 years.

The subjects performed 2 exercise tests twice at 5-week interval. The first test was carried out at the beginning of the pre-competitive phase of training and after completion of this period. The training program (Table 1) was comprised of 25

standard judo training sessions supplemented with additional exercise stimuli in the form of 6 maximum repetitions of 10 to 13-second exercise with 30-second passive rest intervals. Running at maximum speed (4x14m shuttle run) was repeated 6 times during each training session in conditions typical of judo training (barefoot, on a tatami mat).

Aerobic capacity was evaluated based on the results obtained from the laboratory graded exercise test to exercise performed on HP COSMOS mechanical treadmill. The initial running speed was 8 km/h and was increased every 3 minutes by 2.0 km/h until the subject's refusal to perform another run. During the test, we evaluated running speed (V), heart rate (HR), and lactic acid levels (LA) using Dr Lange (Germany) test kits. Aerobic capacity was determined based on the running speed at the anaerobic threshold (V.AT.).

Anaerobic capacity was evaluated from the Quebec test (10 second maximum exercise on a cycle ergometer). Monark 824E cycle ergometer was used in the test, connected on-line with a PC with MCE v.5.0 software [5]. Sensors were fixed to a flywheel which, during a single rotation with the pedals, covered the distance of 6 m. The load was each time equal 7.5% of body mass. Relative values of mechanical work (J/kg), peak power (W/kg) and time (s) of maintaining 97.5% peak power were recorded during the exercise. A 5-minute warm-up procedure on cycle ergometer was used before each test, with a 5-minute rest.

The results obtained were computed statistically by calculating arithmetic means and standard deviations. The sig-

nificance of differences between the tests was evaluated based on the analysis of variance ANOVA with repeated measurements and the post-hoc LSD test, with level of significance set at  $p < 0.05$ . All the computations were carried out using STATISTICA software (v.5.5. Stat Soft. USA).

## Results

Parameters that characterize aerobic capacity were presented in Table 2, whereas anaerobic capacity was illustrated in Table 3.

As results from the data presented in the table above, after four weeks of training with 6 maximum repetitions of anaerobic exercise, a significant increase in mean running speed at anaerobic threshold (V.AT.) was observed in the graded exercise test to exhaustion, with statistically insignificant increase in mean heart rate (HR).

The data contained in the Table 3 show that, in the second period of the study, i.e. after 25 training session where the athletes studied performed in total 150 maximum anaerobic exercise runs, the following findings can be emphasized:

- a significant increase in relative mechanical work in the Quebec test;
- a significant increase in peak power during the Quebec test;
- significant elongation of working time at the level of 97% peak power.

Table 1. Training load during the study period

Number of weeks	5
Number of training sessions	25
Training volume* (min)	2250 min
Number of interval efforts during a training session	6
Number of interval efforts over a study period	150

Notes: \*mean time of 1 training session = 90 min.

Table 2. Running speed (V) and heart rate (HR) at anaerobic threshold (AT) in graded exercise test to exhaustion in testing periods (mean $\pm$ SD)

Variable	1 before pre-competition period	2 after pre-competition period
V. AT. (km/h)	12.25 $\pm$ 1.4	<b>13.98<math>\pm</math>0.9 *</b>
HR. AT. (bpm)	186.8 $\pm$ 12.5	192.5 $\pm$ 12.5

Notes: 1,2 - periods of measurement, \*statistically significant difference ( $p < 0.05$ ),

Table 3. Relative mechanical work (J/kg), peak power (W/kg) and time (s) of maintaining 97.5% of peak power in the periods of measurement (mean $\pm$ SD)

Variable	1. before pre-competition period	2 after pre-competition period
Mechanical work [J/kg]	91.10 $\pm$ 11.39	<b>103.54<math>\pm</math>11.29*</b>
Peak power [W/kg]	11.42 $\pm$ 0.63	<b>12.51<math>\pm</math>1.08*</b>
Time of maintaining 97.5% of peak power [s]	1.72 $\pm$ 0.95	<b>2.14<math>\pm</math>0.55*</b>

Notes: 1,2 - periods of measurement, \* - statistically significant difference ( $p < 0.05$ )

## Discussion

According to Mc Dougal et al. [6], one of the most effective methods to develop anaerobic capacity is short (10-15s) supramaximal exercise with passive rest intervals with duration of 30 to 60 seconds. Bishop et al. [7] demonstrated that the ability to perform repeated sprinting depends on the availability of creatine phosphate sources in muscles and the rate of its re-synthesis, which depends, among other things, on oxidative potential of the muscles and  $\dot{V}O_{2\max}$ . The correlation between anaerobic and aerobic capacity was documented in a study by Bishop et al. [8], who found that the athletes characterized by higher maximum oxygen uptake are able to re-synthesize creatine phosphate faster.

The results obtained in our study demonstrated that special judo training combined with regular exercise in the form of the series of runs at maximum intensity was a strong stimuli for development of anaerobic and aerobic capacity in the athletes studied. This finding is reflected by a 14% increase in mean running speed at the anaerobic threshold during a graded exercise test to exhaustion as well as a significant increase in relative mechanical work (+13.65%), peak power (+9.54%) measured in the Quebec test and a significant elongation

(+24,21%) of time of work at the level of 97.5% of peak power, which seems to be an important aspect of competitive exercise in this sport. There are numerous reports concerning the effect of interval training on anaerobic and aerobic [4,9,10,11]. Farad et al. [12] demonstrated that repeating of 6 sprints over a distance of 35 m divided with 10-second breaks during a 4-week training program for wrestlers improves aerobic capacity of athletes. Wrześniewski [13] found a 13% increase in the running speed at the anaerobic threshold as an effect of the interval exercise (6 repetition of 40-m sprints with 30s rests) used in the competitive period of handball players. Similar findings were reported by Ziemann et al. [14], where a 6-week interval training in a group of young untrained men caused a 10% increase in  $\dot{V}O_{2\max}$ .

## Conclusions

The concept of a training program for pre-competition period presented in this study, which consists in integration of non-specific anaerobic exercise into special judo training might represent an efficient training solution for both judo athletes and athletes from other sports with similar structure of exercise.

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