

# Aerobic capacity of male judokas in comparison with university students of the Faculty of sport and Physical Education

## Authors' Contribution:

- A** Study Design
- B** Data Collection
- C** Statistical Analysis
- D** Manuscript Preparation
- E** Funds Collection

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## Abstract

### Background and Study Aim:

Aerobic capacity is a general parameter of all metabolic processes in the body, representing the overall work capacity of an athlete. In order to evaluate their aerobic capacity, we studied some of the functional abilities of male judokas and compared them with 1<sup>st</sup> and 4<sup>th</sup> year students of the Faculty of Sport and Physical Education.

### Material/Methods:

The investigation included 60 participants in total (20 judokas, 20 1<sup>st</sup> year-students, and 20 4<sup>th</sup> year-students as controls). An assessment of the subjects' aerobic capacity was performed on COSMED treadmill (T 170), and data collected by COSMED gas analyser (CPET; breath-by-breath method). A maximal multi-workload protocol was used on the treadmill, with direct measurements of maximal oxygen consumption ( $VO_{2max}$ ), ventilation (VE), and heart rate (HR) taken during the protocol.

### Results:

Judokas had the highest mean  $VO_{2max}$  (52.6 ml/kg/min), followed by 1<sup>st</sup> year-students (49.2 ml/kg/min), and finally 4<sup>th</sup> year-students (45.8 ml/kg/min).

### Conclusions:

The outcome of this experiment demonstrates that trained judokas have higher  $VO_{2max}$  compared to undergraduate students which is likely a result of training. Relatively low results of 4<sup>th</sup> year students indicate the need for the improvement of the aerobic potential, as well as their relatively bed physical conditioning.

### Key words:

judo • treadmill • maximal oxygen consumption • athletes • physical education students

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## BACKGROUND

Changes in pulmonary function and characteristics with age were first studied over 40 years ago [1]. Following this, many researchers [2–5] have investigated the impact of maturing on physical endurance and cardiorespiratory system.

**Maximal oxygen consumption** has commonly been used as a criterion for the assessment of aerobic capacity and physiological monitoring of athletes [6,7], while oxygen debt has long been a relevant criterion for the assessment of anaerobic capacity [8,9]. Maximal oxygen consumption ( $VO_{2max}$ ) is defined as the level of maxi-

mal oxygen consumption per minute in which further increases in workload do not lead to further increases in oxygen consumption. Functional diagnostics can get valuable information about the current conditions of the cardio-respiratory and muscular systems for gas exchange in condition of a controlled workload. In order to perform and sustain physical activity, it is essential to ensure the balance between the energy production and consumption in the working musculature. This ability in an individual primarily depends on the cardio-respiratory system. It is well established that physical activity has a positive impact on the respiratory system [10,11], as demonstrated by maximal oxygen consumption, pulmonary ventilation and total capacity. Moreover, studies

**Maximal oxygen consumption** – (often abbreviated to  $VO_{2max}$ ) is the maximum volume of oxygen consumed per minute.

**Athletes** – are sportsperson, a person who participates regularly in a sport.

**Treadmill** – is an exercise machine for running or walking without moving any distance.

**Judo** – is a dynamic, physically demanding sport that requires complex skills and tactical excellence for success.

**Physical education students** – are students who have developed the skills and knowledge in the field of sport and physical education.

have shown [12,13] that sedentary lifestyle as well as the factors like aging and reduced physical activity can lead to an accelerated physiological aging.

$VO_{2max}$  is the best index of aerobic capacity [14–16] as an overall sum of all metabolic processes in the body, and is the basis of the physical work capacity.

At the time of enrolment in the Faculty of Sport and Physical Education, all candidates are subjected to a specific entrance exam which requires certain motor, functional and cognitive abilities, along with an excellent overall health status.

During the undergraduate studies of our program, the students must take a number of activity courses until 4<sup>th</sup> year, according to the course requirements. The purpose of this study was to determine the status of the aerobic capacity (as a parameter of their physical ability) of young, male judokas, and compare it to the same number of 1<sup>st</sup> and 4<sup>th</sup> year students. Aerobic capacity is the basis for a successful participation in all the practicum courses that are a part of the program's curriculum, but also for successful performance in **judo**, although this martial art is mostly of the anaerobic type. In combat, aerobic mechanisms are not the primary source of energy, even though they are necessary for the general physical fitness and conditioning.

## MATERIAL AND METHODS

### Study sample

The testing was done in early March of 2009. The sample consisted of 40 male students (FSFV) from the city of Novi Sad, and 20 active male judokas (Group 2). 20 1<sup>st</sup> year (Group 1) and 20 4<sup>th</sup> year male students (Group 3) were tested. All the judokas were current members of the Serbian national team. At the time of the study, none of the university students was a professional athlete. The level of their physical fitness reflected the program's curriculum that included various practice, as well as their individual recreational practices.

### Measurement instruments

The following protocols for the determination of the subjects' functional abilities were applied:

- 1) Maximal oxygen consumption (ml/kg/min),
- 2) Pulmonary ventilation (VE, l/min),
- 3) Maximal heart rate (HR, b/min).

### Study protocol

Prior to the testing, all participants were given detailed instructions and got familiarized with the testing proce-

dure. Aerobic capacity was assessed with the COSMED treadmill (model T 170). Data were collected with COSMED gas analyser (CPET). The protocol itself included progressive increments of workload at the rate of 2 km/hr every 2 min until exhaustion. The test was considered completed when the respiratory quotient reached the reference values, while the subjective state of each participant was monitored during the protocol.

### Data analyses

Differences between the groups (athletes and undergraduate students) were determined by the multivariate analysis of variance (MANOVA) with regard to the subjects' functional abilities, whereas those between the variables were determined by the univariate method (ANOVA). Post-hoc (LSD) test was applied to single out the individual between-group differences.

## RESULTS

Multivariate analyses demonstrated highly significant differences at the level of  $p=.00$ . Descriptive statistics, MANOVA and ANOVA results are presented in Table 1.

Results from Table 1 showed significant differences between-group in two of the three study variables. ANOVA showed that the differences were found in maximal oxygen consumption and pulmonary ventilation at the level of  $p=0.00$ .

It can be seen from Table 2 that judokas showed the highest maximal oxygen consumption and pulmonary ventilation compared to the untrained undergraduates, and that 1<sup>st</sup> year students had better results than 4<sup>th</sup> year students.

Statistically higher values in Maximal heart rate was found between 1<sup>st</sup> year and 4<sup>th</sup> year students, during which 1<sup>st</sup> year students have had higher values. This outcome was not surprising due to the higher maximal oxygen consumption and pulmonary ventilation.

## DISCUSSION

Characteristics of judo are reflected in specific throws and techniques of control. It is thought that movement structures of this activity are highly demanding for most muscle groups [17,18]. Physiological demands of this kind can stress both the anaerobic and aerobic systems. The anaerobic system is responsible (roughly speaking) for quick, brief, explosive bursts of power during a judo match, whereas the aerobic system contributes to the judoka's ability to sustain maximal effort throughout the match, as well as recover faster during short periods of

**Table 1.** Differences in functional variables between judokas and undergraduate students.

Variable	AS			S			f	p
	Judo	Stu. I	Stu. IV	Judo	Stu. I	Stu. IV		
Maximal oxygen consumption (ml/kg/min)	52.6	49.2	45.8	2.5	3.5	5.5	13.8	0.00
Maximal heart rate (HR; b/min)	191.1	191.4	187.8	3.7	5.2	7.1	2.55	0.87
Pulmonary ventilation (VE; l/min)	140.9	130.4	113.3	10.4	17.0	20.8	14.3	0.00

F=5.75 p=0.00.

AS – mean; S – Standard deviation; II – Judokas; I – 1<sup>st</sup> year students (FSFV); IV – 4<sup>th</sup> year students (FSFV); F – multivariate F test; P – level of statistical significance; f – univariate f test.

**Table 2.** Differences between groups as determined by LSD post hoc test.

Variable	(I)	(J)	Difference	P
			AS (I-J)	
Maximal oxygen consumption (ml/kg/min)	1 <sup>st</sup> year students	Judokas	-3.4	0.01
	1 <sup>st</sup> year students	4 <sup>th</sup> year students	3.3	0.01
	Judokas	4 <sup>th</sup> year students	6.7	0.00
Maximal heart rate (HR; b/min)	1 <sup>st</sup> year students	Judokas	.35	0.84
	1 <sup>st</sup> year students	4 <sup>th</sup> year students	3.6	0.04
	Judokas	4 <sup>th</sup> year students	3.2	0.06
Pulmonary ventilation (VE; l/min)	1 <sup>st</sup> year students	Judokas	-10.5	0.05
	1 <sup>st</sup> year students	4 <sup>th</sup> year students	17.1	0.00
	Judokas	4 <sup>th</sup> year students	27.6	0.00

rest or lower intensity [19–21]. A well developed aerobic capacity in aerobic sports allows faster decomposition accumulated lactic acid, more work can be performed in training session, because the body is able to recover faster and reduce the time of recovery between two matches. Research results has shown that judokas had statistically better results in comparison with untrained students, and also similarly to elite judokas [22–24]. Based on the results of the present study, it can be concluded that judokas had the best aerobic potential compared with undergrad students, as suggested by maximal oxygen consumption and pulmonary ventilation as key indices of the overall aerobic ability. Additionally, one can infer that 1<sup>st</sup> year students had better aerobic potential and that they were better physically prepared than 4<sup>th</sup> year students. Statistically higher maximal heart rate of the former is also an indicator of generally better ability to perform under the conditions of high-intensity exercise.

## CONCLUSIONS

It is extremely important to develop aerobic mechanisms as the base for a high-level athletic performance. On the grounds of the outcomes of this investigation, it can be inferred that judokas have a well-developed aerobic capacity, which is most likely an effect of a combination of training and competition. Students of the 1<sup>st</sup> year performed relatively well and only slightly worse than the judokas, which speaks favourably of their physical fitness and ability to be subjected to high-intensity effort of the aerobic type. On the other hand, 4<sup>th</sup> year students had the poorest results as demonstrated by all the cardio-respiratory indicators, possibly due to a reduced overall physical activity level that is commonly seen after the first three years of the program. This finding is not surprising considering that the lack of training can have adverse effects on aerobic capacity. It also prompts the need for a systematic effort to maintain the level of the students' functional abilities, especially because of the abrupt withdrawal of activity courses seen in the final year of study.

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