©Academy of Physical Education and Sport in Gdansk, ©MEDSPORTPRESS, Volume 1, No 2, 2009, 105-110

The Level of Aerobic and Anaerobic Capacity and the Results of a Special Mobility Fitness Test of Female Judo Contestants

DOI: 10.2478/v10131-009-0012-y

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

Beata Wolska (A,B,D,E,F), **Valerij Smulskij** (A,B,C,D,E), **Władysław Jagiełło** (A,B,E,F)

Jedrzej Sniadecki Academy of Physical Education and Sport in Gdansk, Poland

Key words: *judo, female contestants, special fitness, aerobic, anaerobic function*

Abstract

Background: *The purpose of this work is to determine the correlation between the indexes of the special fitness test and the parameters of aerobic and anaerobic capacities of women judo competitors during the preparation to the competitive period.*

Material/Methods: *In the research presented in the paper the level of aerobic and anaerobic capacity and the results of a special mobility fitness test of female judo contestants, either members of the Olympic and National Teams or their immediate reserves, was determined (n=11). In order to assess the aerobic capacity a test with increasing load until the refusal to continue the test was applied, while the anaerobic capacity was assessed thanks to the application of 30 seconds Wingate Test with a load on lower limbs. Within the framework of the assessment of special mobility fitness, the Special Judo Fitness Test (SFJT) was applied.*

Results: *An analysis of correlation between the anthropometric indices and SJFT indices was carried out; besides that a correlation between the indices of aerobic and anaerobic capacity and the results of the special mobility fitness test were analyzed.*

Conclusions: *On the basis of analysis of the empirical material it was determined that the indices of special mobility fitness test clearly correlated with the relative values of indices that characterized the aerobic and anaerobic capacity. A lower level of indices of aerobic and anaerobic capacity in comparison with results obtained by other authors was observed, while the indices diagnosing the level of special fitness of female judo contestants had a higher value.*

Word count: 2 141
Tables: 5
Figures: -
References: 17

Received: June 2009
Accepted: September 2009
Published: December 2009

Address for correspondence:
Ms Beata Wolska
Academy of Physical Education and Sport, Department of Martial Arts, 80-336 Gdańsk, Poland, ul. K. Górskiego 1
Phone: +4858 554-74-50, e-mail: beata.wolska@wp.pl

Introduction

Judo is one of the sports of changeable intensity of effort. During contest, the non-stop periods of maximum or submaximum intensity are separated by longer or shorter breaks [1]. The analysis of judo competitive actions shows that all ducts of energetic functions are used. Judo techniques, such as throws, armlocks, choking and immobilisation techniques, call for high efficiency phosphogen processes – anaerobic non-lactic-acid and lactic-acid (glycolic) [2]. Considering the contest duration and the number of contests during a tournament, aerobic capacity is also important in terms of better use of the judoka's system and theprompt recuperation process [3].

In hitherto studies, several laboratory tests have been used to assess effort capacity [4,5,6]. But, it seems that the best tests are these which will give similar effort responses as those ones observed in a competition.

The purpose of this work is to determine the correlation between the indexes of the

special fitness test and the parameters of aerobic and anaerobic capacities of women judo competitors during the preparation to the competitive period.

Material and Methods

Eleven senior women judo competitors were subject to our study; they were members of the Olympic and National Teams. Most competitors were from the AZS AWFiS Sport Club-Gdańsk, current Poland's Champion. The examinations were carried out in July 2007 at the Combat Sport Department and the Functional Diagnosis Laboratory at AWFiS Gdańsk.

In order to determine the somatic features, body heights and body mass indexes and components were measured. Body mass index (BMI), fat mass content (FAT) and fat-free mass content (FFM), were measured by the TBF-410 TANITA MA III Body Composition Analyzer, with making use of the bioimpedance electric metod. Special Judo Fitness Test (SJFT), was used to assess special effort capacities [7]. The test is composed of three periods of work: 15 s (series A), 30 s (series B), 30 s (series C), separated by 10 s breaks. During each effort the tested athlete's task was to perform the greatest number of seoi-nage throws, with two partners of similar heights and the same weight category who stood 6 m apart each other with the thrower between them. Immediately on completion of series C and after 1 min since the test completion HR measurement was taken [bt·min^{-1}]. To measure the frequency of the heart rate, a sport tester "Polar Sport Tester" was used (POLAR 810 I™ Finland). On the basis of the obtained results, the index was calculated:

$$I_{SJFT} = \frac{\text{HR after effort (bt·min}^{1}\text{) +HR after 1 min. since effort comp. (bt·min}^{1}\text{)}}{\text{Sum of throws (series A + series B +series C)}}$$

To assess aerobic capacity in a laboratory, the test of increasing load up to exhaustion was used [8]. The computerised analyzer of exhalation gases the Cosmed brand K4b^{2} and the "Monark 828 E Ergometric" ergometer were used. The trial was performed in a sitting position. The test started with five-minute physical effort with the load of 1.5 watt per one kilogram of body mass (W·kg^{-1}), at rounds of frequency of 50 per minute (50·min^{-1}). At the main stage of the test the load was increased by 25 W every minute up to exhaustion phase. The heart rate was measured by the POLAR 810 i™ (Finland).

To assess anaerobic capacity in a laboratory, the Wingate Anaerobic Test (WAnT) of 30-seconds version was used [9]. The examined competitors performed the test for lower limbs, using

the "Monark 824 Ergometric", with the loads related to their body mass: 75 g·kg^{-1}. The MCE v 2.0 computer program was used for calculating the mechanic indexes WAnT [10]. The "STATISTICA 6.0 PL" computer program was used for the mathematic-statistical data processing: arithmetic mean (M), standard deviation (SD), correlation coefficient (r), mean differences significance (p).

Results

Tab. 1. The anthropometric features of women judo competitors (n=11)

Statistics	Experience	Age (years)	Height (cm)	Weight (kg)	BMI	FAT (kg)	FAT (%)	FFM (kg)	FFM (%)
M	14.2	25.2	168.2	65.6	23.1	13.6	19.9	52.1	80.1
SD	4.0	3.7	5.5	12.1	3.2	6.6	5.4	6.2	5.4

The presented values are mean±standard deviation, BMI-body mass index, FAT-fat mass content, FFM-fat-free mass content

The values of indexes were obtained by means of the Special Judo Fitness Test, which determine the levels of special fitness in women judo competitors, and which have been presented in Table 2.

Tab. 2. The mean values of the SJFT indexes of women judo competitors (n=11)

Statistics	1	2	3	4	5	6	7
M	5.3	9.7	9.3	24.3	175	129	12.6
SD	0.47	0.79	0.79	1.8	7.0	12.9	0.69

1-the number of throws in series A; 2- the number of throws in series B; 3-the number of throws in series C; 4-sum of throws in three series; 5-HR immediately after series C(bt·min^{-1}); 6-HR after 1 min rest since series C (bt·min^{-1}); 7-I_{SJFT} (index)

The correlation analysis between the somatic indexes and the SJFT ones revealed a negative correlation between body height and the number of throws in series C (r=-0.71), the sum of throws (r=-0.66); at p<0.05. A negative correlation was also observed between FFM (kg) and the number of throws in series A (r=-0.68), the number of throws in series C (r=-0.67), the sum of throws (r=-0.73); at p<0.05.

The mean values of the selected indexes which relate to the respiratory and circulation systems, and the relevant values of standard deviations have been presented in Table 3. It has been revealed that the absolute value of critical strength was 252±32 W, and when converted per 1 kilogram of body mass it was 3.9±0.70 W·kg^{-1}. Maximum oxygen intake was 2619±311 mL·min^{-1}, which relatively amounted to 41.0±6.4 mL·kg^{-1}·min^{-1}. Mean values of the heart rate maximum (HR_{max}) at test effort up to the exhaustion phase oscillated around 181.5±7.6 bt·min^{-1}.

Mean values of the basic parameters of the strength dynamics during WAnT and their standard deviations have been presented in Table 4.

The absolute values of mean strength ($P_{WAnTmid}$) was 477±50 W, whereas the relative values (per one kilogram of body mass) was 7.63±0.72 W·kg^{-1}. Maximum power (MP_{WAnT}) recorded during WAnT and represented with absolute value was up to 589±72 W, and relative value 9.10±0.91 W·kg^{-1}. The examined women did their work (W_{tot}) at the levels of 14.20±1.60 kJ, which per one kilogram of body mass t was 220±22 J·kg^{-1}. Other indexes have also been analyzed; they determined the anaerobic capacity, such as the time of assuming maximum power (TUZ), and the time of keeping maximum power (TUT). The values of these indexes were 4.63±0.60 s and

3.20±1.25 s, respectively. The value of the decreasing speed power index (WSM) during 30-second effort was 0.202±0.043 $W \cdot kg^{-1} \cdot s$. The correlation coefficients of physiological parameters were shown in Table 5.

Tab. 3.The aerobic capacity indexes of women judo competitors (n=11)

VE_{max} ($L \cdot min^{-1}$)	103.5±18.3
$VO_{2\,max}$ ($mL \cdot min^{-1}$)	2619±311
$VCO_{2\,max}$ ($mL \cdot min^{-1}$)	2981±482
$VO_{2\,max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$)	41.0±6.4
$VE \cdot VO_2^{-1}$	44.3±15.4
$VE \cdot VCO_2^{-1}$	41.3±7.7
RQ	1.20±0.17
HR_{max}	181.5±7.6
$O_2 \cdot HR^{-1}$ (mL)	15.2±2.6
W_{cr} (W)	252±32.5
W_{cr} ($W \cdot kg^{-1}$)	3.9±0.70

Tab. 4.The anaerobic capacity indexes of women judo competitors (n=11)

$P_{WAnTmid}$ (W)	477±50
$P_{WAnTmid}$ ($W \cdot kg^{-1}$)	7.63±0.72
W_{tot} (kJ)	14.20±1.60
W_{tot} ($J \cdot kg^{-1}$)	220±22
MP_{WAnT} (W)	589±72
MP_{WAnT} ($W \cdot kg^{-1}$)	9.10±0.91
WSM ($W \cdot kg^{-1} \cdot s$)	0.202±0.043
TUZ (s)	4.63±0.60
TUT (s)	3.20±1.25

Tab. 5.The correlation indexes of the capacity tests and the SJFT of women judo competitors (n=11)

	$VO_{2\,max}$ ($mL \cdot min^{-1}$)	$VO_{2\,max}$ ($mL \cdot kg^{-1} \cdot$ [illegible])	$VE \cdot VO_2^{-1}$	W_{Cr} (W)	W_{cr} ($W \cdot kg^{-1}$)	$P_{WAnTmid}$ (W)	$P_{WAnTmid}$ ($W \cdot kg^{-1}$)	W_{tot} (kJ)	W_{tot} ($J \cdot kg^{-1}$])	MP_{WAnT} (W)	MP_{WAnT} ($W \cdot kg^{-1}$)
Series A SJFT	-0.16	0.55	-0.26	-0.04	0.55	-0.31	0.63	-0.42	0.63	-0.36	0.62
Series B SJFT	0.08	**0.61**	-0.3	0.22	**0.63**	-0.41	0.61	-0.45	0.62	-0.38	0.63
Series C SJFT	0.05	**0.64**	-0.17	0.27	**0.68**	-0.26	**0.67**	-0.33	**0.68**	-0.23	**0.72**
Sum of throws in three series	0.01	**0.69**	-0.27	0.20	**0.72**	-0.36	**0.70**	-0.43	**0.71**	-0.35	**0.73**
HR after series C($bt \cdot min^{-1}$)	-0.28	-0.02	**-0.69**	-0.38	-0.11	-0.31	-0.09	-0.31	-0.07	-0.22	-0.04
HR after 1 min rest($bt \cdot min^{-1}$)	-0.45	0.08	-0.51	-0.13	0.24	-0.29	0.26	-0.31	0.27	-0.15	0.38
I_{SJFT} (index)	-0.50	**-0.89**	-0.34	-0.55	**-0.84**	0.10	**-0.76**	0.19	**-0.76**	0.24	**-0.68**

The strongest relations referred to the relative values of VO_{2max} ($mL \cdot kg^{-1} \cdot min^{-1}$) and W_{cr} ($W \cdot kg^{-1}$) in most indexes of the special fitness test ($p<0.05$). Moreover, the lower values at SJFT were in relation to high relative values of $VO_{2\,max}$ and W_{cr}. It is also important to see the negative correlation between the ventilation oxygen consumption equivalent ($VE \cdot VO_2^{-1}$) and HR immediately after completing the test ($p<0.05$). Among the WAnT indexes the relative values of $P_{WAnTmid}$ ($W \cdot kg^{-1}$), W_{tot} ($J \cdot kg^{-1}$) and MP_{WAnT} ($W \cdot kg^{-1}$) ($p<0.05$) manifested the strongest relations to SJFT. The negative relations between the index of SJFT and the relative values of the WAnT ($p<0.05$) are also noteworthy (Table 5).

Discussion

The results of the correlation analysis between the somatic indexes and the performance in the SJFT suggest that shorter women competitors and with lower FFM (kg) are able to execute more throws in the SJFT. The ability to execute many throws within a short period of time depends mainly on the anaerobic capacity of a competitor, whereas the HR restitution value is connected with aerobic metabolism [11].

The index value illustrates the levels of performance at the SJFT. Its lower values indicate the higher performance. The examined women competitors obtained similar values of that index i.e. 12.6±0.69, just like Brazilian competitors 12.62±1.48 [12], who had been prepared to the Pan American Games, and slightly lower values as compared to those ones in Sterkowicz's research 13.23±1.54 [13]. The values of HR obtained by Franchini and others [12] after completing the test was nearly the same as that one in our studies, and it was 177±14 bt·min^{-1}. But HR measured 1 minute after the test was significantly higher in Brazilian women and it was 156±5 bt·min^{-1} in comparison to our studies, i.e. 129±2.9 bt·min^{-1}.

Extensive research confirms that women judo competitors have significantly high aerobic and anaerobic capacity. In accordance with Laskowski's data, the mean value of maximum oxygen intake (VO_{2max}) observed in female competitors from the National Judo Team reached the values of 48.6-51.8 mL·kg^{-1}·min^{-1} [2]. The same index, according to Mickiewicz's research, in women who practice judo, was 49.9 mL·kg^{-1}·min^{-1}. In our studies, for VO_{2max} we obtained the mean value of 41.0±6.4 mL·kg^{-1}·min^{-1}, which was significantly lower in comparison to that one obtained by Callister and others, i.e. 52.0 mL·kg^{-1}·min^{-1} [15].

The maximum power index (MP_{WAnT}), and especially absolute value of mean power ($P_{WAnTmid}$) are regarded as the exponents of speed predispositions based on anaerobic capacity. Maximum anaerobic power, according to Bellotti and others, greatly affects the competitive performance of a judoka [16]. The mean value of maximum anaerobic power, in the research by Zdanowicz and Wojczuk, was determined at the levels of 9.63 W·kg^{-1}, and 10.57 W·kg^{-1} in the women judo competitors from the National Judo Team [17]. Lower mean values of MP_{WAnT} 9.10±0.91 W·kg^{-1} have been observed in our studies.

In the studies by Laskowski it was found, that during a 30-second test women judo competitors carried out the work at the levels of 238.8-255.0 J·kg^{-1} [2], while the performed mean work, according to Zdanowicz and Wojczuk was at the level of 220.8±16.9 J·kg^{-1} [4], similar to our findings 220.0±22.0 J·kg^{-1}.

The correlation analysis, between aerobic and anaerobic capacities and the performance from the special fitness test has shown significant relations. The number of throws, executed at particular stages of the test, clearly correlated with the relative values of the indexes which characterize the function of the circulation and respiratory systems ($VO_{2\ max}$, W_{cr}), as well as with the relative values of the $P_{WAnTmid}$, W_{tot}, MP_{WAnT}, obtained during the WAnT. In the studies by Franchini and others [12], relative mean power in the Wingate test corresponded to the number of throws in series A (r=0.87), in series C (r=0.75), sum of throws (r=0.79), and the SJFT index (r=-0.83). Whereas the index of power decrease correlated with the number of throws in series B (r=-0.75), in series C (r=-0.72), and sum of throws at the SJFT (r=-0.71).

Thus, the sum of all throws in the SJFT significantly correlated both with the parameters of aerobic and anaerobic capacities. Moreover, the SJFT index strongly negatively correlated with the relative values of aerobic ($VO_{2\ max}$, W_{cr}), and anaerobic capacities ($P_{WAnTmid}$, W_{tot}), and moderately negatively with the relative values of maximum power obtained during the WAnT.

Conclusion

On the ground of the empirical material and its analysis, it has been determined that the indexes of the special fitness test strongly corresponded to the relative values of the indexes which characterize aerobic and anaerobic capacities. It has been ascertained that the examined women competitors, at the beginning of their preparation period, had lower values of the indexes of aerobic and anaerobic capacities in comparison to other studies. However, comparing the results of the SJFT from the relevant literature, the higher values of indexes which diagnose special fitness have been observed.

References

1. Sikorski W. Aktualne problemy treningu i walki sportowej w judo [Current issues on judo training and sports combat]. *Prace i Materiały Instytutu Sportu*, *Warszawa* 1985;5:63-65.
2. Laskowski R. Obciążenia treningowe a wydolność fizyczna kobiet trenujących judo [Training loads and physical capacity in female practicing judo]. Gdańsk: AWFiS; 2007.
3. Ikai M, Haga S, Kaneko M. The characteristic of physical fitness of judoists from the viewpoint of respiratory and cardiovascular functions. *Bulletin of the Association for the Scientific Studies on Judo*. *Kodokan Report* 1972, 4.
4. Zdanowicz R, Wojczuk J. Wydolność beztlenowa zawodników i zawodniczek judo [Anaerobic capacity of judo contestants]. *Sport Wyczynowy* 1984;12(240):29-36.
5. Mickiewicz G, Starczewska J, Borkowski L. Fizjologiczna charakterystyka zawodników Kadry Narodowej Judo [Physiological characteristics of the Polish National Judo Team members]. *Sport Wyczynowy* 1988;9(285):46-50.
6. Mickiewicz G. Testy laboratoryjne do oceny zdolności wysiłkowej judoków [Laboratory tests of exertion capacity in judo contestants]. *Sport Wyczynowy* 1988;9(285):41-45.
7. Sterkowicz S. Test specjalnej sprawności ruchowej w judo [Special mobility test in judo]. *Antropomotoryka*1995;12-13:29-44.
8. Suchanowski A. Efficiency and restitution. *Research Yearbook*, *Studies in the Theory of Physical Education and Sport* 1993;1(1):97-105.
9. Bar-Or O. The Wingate Anaerobic Test – an update on methodology. Reliability and validity. *Sports Med* 1987;4:381-394.
10. Staniak Z. Informatyczny system do wspomagania testów wydolnościowych prowadzonych na cykloergometrach [IT system to support efficiency tests on cycloergometers]. *Trening* 1994;1:251-257.
11. Sterkowicz S, Franchini E. Kompleksowa ocena sprawności motorycznej w judo w świetle rezultatów specyficznego testu – Special Judo Fitness Test (SJFT). In: Kuder A, Perkowski K, Śledziewski D, editors. *Proces doskonalenia treningu i walki sportowej [Process of improvement in sports struggle].* Vol. 3, Warszawa: AWF; 2006, 23-29.
12. Franchini E, Matsushigue KA, Kiss MAPDM, Sterkowicz S. A case study of physiological and performance changes in female judo players preparing for the Pan-American Games. *Rev Bras Clên* 2001;9(2):21-27.
13. Sterkowicz S. Specjalna sprawność ruchowa [Special mobility fitness]. Proceedings of The Fourth International Conference Sex Dimorphism in Sport. Katowice, 1997,188-195.
14. Franchini E, Nakamura FY,Takito MY, Kiss MAPDM, Sterkowicz S. Anállise de um teste especifico para o judô. *Revista Kinesis* 1999;21:91-108.
15. Callister R, Callister RJ, Staron RS, Fleck SJ, Tesch P, Dudley GA. Physiological characteristics of elite judo athletes. *Int J Sports Med* 1991;12(2):196-203.
16. Belotti P, Benzi G, Dal Monte A, Donati A, Matteucci E, Vittori C. Classificazione degli Sport determinazione dei mezzi di allenamento. *Atleticastudi* 1978;3-4:29-46.
17. Borkowski L, Faff J, Starczewska-Czapowska J. Ocena wydolności tlenowej i beztlenowej zawodników kadry narodowej judo [Assessment on aerobic and anaerobic capacity in members of the Polish National Judo Team]. In: Sozański H, Perkowski K, Śledziewski D, editors. *Efektywność systemów szkolenia w różnych dyscyplinach sportu* [*Efficiency of training systems in various sports disciplines*]. Warszawa: AWF; 2000, 136-138.