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

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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 (SJFT) 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.

Keywords

judo, female contestants, special fitness, aerobic, anaerobic function

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

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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 the prompt 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 method. 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 [$\text{bt}\cdot\text{min}^{-1}$]. 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:

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

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 K4b² 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 ($\text{W}\cdot\text{kg}^{-1}$), at rounds of frequency of 50 per minute ($50\cdot\text{min}^{-1}$). 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: $75 \text{ g}\cdot\text{kg}^{-1}$. 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($\text{bt}\cdot\text{min}^{-1}$); 6-HR after 1 min rest since series C ($\text{bt}\cdot\text{min}^{-1}$); 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 $252\pm 32 \text{ W}$, and when converted per 1 kilogram of body mass it was $3.9\pm 0.70 \text{ W}\cdot\text{kg}^{-1}$. Maximum oxygen intake was $2619\pm 311 \text{ mL}\cdot\text{min}^{-1}$, which relatively amounted to $41.0\pm 6.4 \text{ mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$. Mean values of the heart rate maximum (HR_{max}) at test effort up to the exhaustion phase oscillated around $181.5\pm 7.6 \text{ bt}\cdot\text{min}^{-1}$.

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 $477\pm 50 \text{ W}$, whereas the relative values (per one kilogram of body mass) was $7.63\pm 0.72 \text{ W}\cdot\text{kg}^{-1}$. Maximum power (MP_{WAnT}) recorded during WAnT and represented with absolute value was up to $589\pm 72 \text{ W}$, and relative value $9.10\pm 0.91 \text{ W}\cdot\text{kg}^{-1}$. The examined women did their work (W_{tot}) at the levels of $14.20\pm 1.60 \text{ kJ}$, which per one kilogram of body mass t was $220\pm 22 \text{ J}\cdot\text{kg}^{-1}$. 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 $4.63\pm 0.60 \text{ s}$ 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·kg⁻¹·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·min ⁻¹)	103.5±18.3
VO _{2max} (mL·min ⁻¹)	2619±311
VCO _{2max} (mL·min ⁻¹)	2981±482
VO _{2max} (mL·kg ⁻¹ ·min ⁻¹)	41.0±6.4
VE·VO ₂ ⁻¹	44.3±15.4
VE·VCO ₂ ⁻¹	41.3±7.7
RQ	1.20±0.17
HR _{max}	181.5±7.6
O ₂ ·HR ⁻¹ (mL)	15.2±2.6
W _{cr} (W)	252±32.5
W _{cr} (W·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·kg ⁻¹)	7.63±0.72
W _{tot} (kJ)	14.20±1.60
W _{tot} (J·kg ⁻¹)	220±22
MP _{WAnT} (W)	589±72
MP _{WAnT} (W·kg ⁻¹)	9.10±0.91
WSM (W·kg ⁻¹ ·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 _{2max} (mL·min ⁻¹)	VO _{2max} (mL·kg ⁻¹ ·min ⁻¹)	VE·VO ₂ ⁻¹	W _{cr} (W)	W _{cr} (W·kg ⁻¹)	P _{WAnTmid} (W)	P _{WAnTmid} (W·kg ⁻¹)	W _{tot} (kJ)	W _{tot} (J·kg ⁻¹)	MP _{WAnT} (W)	MP _{WAnT} (W·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·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·min ⁻¹)	-0.45	0.08	-0.51	-0.13	0.24	-0.29	0.26	-0.31	0.27	-0.15	0.38
Is _{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·kg⁻¹·min⁻¹) and W_{cr} (W·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_{2max} and W_{cr}. It is also important to see the negative correlation between the ventilation oxygen consumption equivalent (VE·VO₂⁻¹) and HR immediately after completing the test (p<0.05). Among the WAnT indexes the relative values of P_{WAnTmid} (W·kg⁻¹), W_{tot} (J·kg⁻¹) and MP_{WAnT} (W·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 $\text{bt} \cdot \text{min}^{-1}$. But HR measured 1 minute after the test was significantly higher in Brazilian women and it was 156 ± 5 $\text{bt} \cdot \text{min}^{-1}$ in comparison to our studies, i.e. 129 ± 2.9 $\text{bt} \cdot \text{min}^{-1}$.

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 ($\text{VO}_{2\text{max}}$) observed in female competitors from the National Judo Team reached the values of $48.6\text{--}51.8$ $\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ [2]. The same index, according to Mickiewicz's research, in women who practice judo, was 49.9 $\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$. In our studies, for $\text{VO}_{2\text{max}}$ we obtained the mean value of 41.0 ± 6.4 $\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, which was significantly lower in comparison to that one obtained by Callister and others, i.e. 52.0 $\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ [15].

The maximum power index ($\text{MP}_{\text{WAN}T}$), and especially absolute value of mean power ($\text{P}_{\text{WAN}T\text{mid}}$) 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 $\text{W} \cdot \text{kg}^{-1}$, and 10.57 $\text{W} \cdot \text{kg}^{-1}$ in the women judo competitors from the National Judo Team [17]. Lower mean values of $\text{MP}_{\text{WAN}T}$ 9.10 ± 0.91 $\text{W} \cdot \text{kg}^{-1}$ 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 $238.8\text{--}255.0$ $\text{J} \cdot \text{kg}^{-1}$ [2], while the performed mean work, according to Zdanowicz and Wojczuk was at the level of 220.8 ± 16.9 $\text{J} \cdot \text{kg}^{-1}$ [4], similar to our findings 220.0 ± 22.0 $\text{J} \cdot \text{kg}^{-1}$.

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 ($\text{VO}_{2\text{max}}$, W_{cr}), as well as with the relative values of the $\text{P}_{\text{WAN}T\text{mid}}$, W_{tot} , $\text{MP}_{\text{WAN}T}$, obtained during the WAN T . 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 ($\text{VO}_{2\text{max}}$, W_{cr}), and anaerobic capacities ($\text{P}_{\text{WAN}T\text{mid}}$, W_{tot}), and moderately negatively with the relative values of maximum power obtained during the WAN T .

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.

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