The correlation of general and sport-specific preparation indices of elite female judo competitors with their age-somatic characteristics

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Source of support: Departmental sources

Received: 9 September 2011; **Accepted:** 8 November 2011; **Published online:** 22 November 2011

Abstract

Background and Study Aim: The purpose of this work was to determine the correlation between indices of the general and sport-specific preparation with the age-somatic parameters of elite female judo competitors during the preparation to the competitive period.

Material/Methods: Eleven senior female judo competitors – members of the Olympic and National Teams in judo participated in the study. Their average age was 25.2±3.7 years, and athletic experience – 14.2±4.0 years. To determine the somatic features – body height, body mass index (BMI) and body components: FAT_{kg}, $FAT_{\%}$, FFM_{kg}, $FFM_{\%}$, TBW_{kg}, $TBW_{\%}$ – the Body Composition Analyser was used. To assess sport-specific preparation the standard IPFT test was used. The level of sport-specific preparation of athletes was assessed by Sterkowicz's test (SJFT).

Results: The female judo competitors who have lower body weight, smaller values of BMI, absolute and percentage values of the fatty component, the absolute indices of fat-free and a liquid component of body mass, but a higher percentage of the latter two components, perform better in all IPFT running tests. Of the IPFT power performance test only the "maximum amount of the trunk slopes from the supine position for 30 s" index showed a statistically significant correlation with body length of the female judo competitors, as well as with the content of fat in their body mass. In this case, female athletes who had a smaller body length and lower absolute content of the fat-free component in it showed the best results. The athletes who had a smaller body length as well as lower absolute content fat and liquid components in the body demonstrated a higher level of sport-specific preparation in the SJFT test.

Conclusions: The presented data are considered from the standpoint of their significance and prospects of their use in future studies related to the problem of improving the effectiveness of the training process of the female judo competitors at different stages of long-term preparation.

Key words: female judo • physical preparation • somatic characteristics

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Background

One of the main problems to be solved in the process of athletic training is how to achieve the required level of motor qualities, as well as opportunities for functional systems of the body, carrying the main burden in a specific kind of sport. Solution of this problem is part of physical training, ensuring the formation of general and sport-specific preparation and their appearance in competition. It is known that each of these, as well as other aspects of preparing, combined in a compound complex, aim at achieving the highest sports results [1]. The degree of inclusion of various elements in such a complex, their relationship and interaction are conditioned

Judo, women – an Olympic sports discipline practiced by women

Physical preparation – activities aiming at raising the athletes fitness potential at the highest level mainly through perfecting functions of various organs and systems in the body. It is frequently called a fitness preparation.

Somatic characteristics – somatic features defining the properties of human body composition. It is often used, e.g. to define the body somatotype, proportions or composition of the body.

by the laws of the formation of functional systems [2], aimed at the ultimate, specific to the sports discipline, effect of training and competitive activity.

In the analysis of indices of athletes' general and sport-specific preparation it should be borne in mind that the differentiation of physical training into general and special is relative. In reality, this distinction does not characterize somewhat diverse, but only in certain respects different, sides of the same complex process, which are not only intertwined, but also pass each other in the dynamics of the given activity [3].

There is no doubt that judo generates its own particular spectrum of levels and interrelationships of indices of general and sport-specific preparation, which account for all phases of long-term preparation and may create favourable conditions for optimizing the training process and achieving high sports results [4].

However, it is reasonable to expect that the formation of such a spectrum can be determined by several factors, among which features of the interrelationship of athletes' age-somatic characteristics with indices of their general and sport-specific preparation deserve some attention.

Currently, a substantial body of information has been accumulated on determining properties of judo competitors' body composition [5–7] and on determining their morphological differentiation with consideration of particular weight categories [8,9]. Also defining the influence of selected somatic indices on training highly-qualified judokas has been the subject of research [10] just as searching for correlations between body composition and the techniques used [11].

Unfortunately, the available literature does not provide enough information on the connections between general and special physical fitness indices and female judokas' somatic indices.

In this respect the **purpose** of this study was to determine the correlation between the indices of the general and sport-specific preparation with the age-somatic parameters of elite female judo competitors during the preparation to the competitive period.

Material and Methods

Eleven senior female judo competitors – members of the Olympic and National Teams in judo participated in the study conducted at the end of the preparatory period of 2007. Their average age was 25.2±3.7 years, and athletic experience – 14.2±4.0 years. The tests were carried out in the Combat Sport Department and the Functional Diagnosis Laboratory at Academy of Physical Education and Sport in Gdansk (Poland).

In order to determine somatic features, body height, body mass indices and body components: fat mass content (FAT_{kg}, $FAT_{\%}$), fat-free mass content (FFM_{kg}, $FFM_{\%}$) and the liquid content in the body (TBW_{kg}, $TBW_{\%}$) were measured by the TBF-410 TANITA MA III Body Composition Analyser, with use of the bio-impedance electric method. The body mass index (BMI) [$kg \cdot m^{-2}$] was also calculated [12,13].

In assessing athletes' general physical fitness we have focused on the performance in the standard international IPFT test [14], namely, on the results shown in the following tests: – 50 m run (s), standing long jump (cm); 800 m run (s); dominant hand grip (kg), flexed arm hang (s), shuttle run 4×10 m (s), 30 s sit-ups, slope trunk forward (cm) and the integral index of the IPFT test (total items – Σ pts).

The level of athletes' sport-specific preparation was assessed by Sterkowicz's (SJFT) test [15] (presented in tutorial movie at *www.archbudo.com/text.php?ids=252*). The SJFT test is composed of three periods of work: 15 s (series A), 30 s (series B) and 30 s (series C), separated by 10 s breaks. During each effort the tested athlete's task was to perform the greatest number of *"seoinage"* throws, with two partners of similar heights and the same weight category that were located at a distance of 6 meters against each other. Immediately on completion of series C and after 1 min since the test completion HR measurement was taken [$bt \cdot min^{-1}$]. To measure the frequency of the heart rate, a sport tester (POLAR 810 I™ Finland) was used. On the basis of the obtained results, the index was calculated:

$$I_{SJFT} = \frac{\text{HR after effort [bt·min}^{-1}\text{]}}{\text{+HR after 1 min. effort. [bt·min}^{1}\text{]}}$$

$$\text{Sum of throws (series A + series B +series C)}$$

The STATISTICA 7.0 PL software was used for the statistical data processing: mean (M), standard deviation (SD), correlation coefficient (r).

Results

The mean values of the examined competitors' somatic features are presented in Table 1.

The following tables present the results of the female athletes' determined indices as both general physical fitness in the IPFT test (in absolute terms and in items of IPFT) (Table 2), and sport-specific preparation in SJFT (Table 3).

Table 1. Somatic indices of female judo competitors (n=11).

Statistics	Indices								
	Height (cm)	Weight (kg)	BMI	FAT (kg)	FAT (%)	FFM (kg)	FFM (%)	TBW (kg)	TBW (%)
M	168.2	65.6	23.1	13.6	19.9	52.1	80.1	38.2	58.1
SD	5.5	12.1	3.2	6.6	5.4	6.2	5.4	4.5	4.0

Table 2. Indices of sport-specific preparation of female judo competitors in the IPFT test (n=11).

Statistics	Indices																Integral index (pts)
	50 m run [s]		Standing long jump (cm)		800 m run (s)		Dominant hand grip (kg)		Flexed arm hang (s)		Shuttle run 4×10 m (s)		30 s sit-ups		Slope trunk forward (cm)		
	s	pts	cm	pts	s	pts	kg	pts	s	pts	s	pts	amount.	pts	cm	pts	
M	7.2	70.7	212	70.5	197.5	61.8	37.6	66.3	32.4	63.8	10.6	67.9	31.3	73.8	15.5	59.5	534.4
SD	1.11	20.4	12.3	5.0	20.0	5.5	6.4	11.2	16.4	10.2	0.87	7.8	3.2	8.3	7.3	17.0	

Table 3. Indices of sport-specific preparation of female judo competitors in the SJFT test (n=11).

Statistics	Indices						
	Number of throws in series A	Number of throws in series B	Number of throws in series C	Sum of throws in three series	HR immediately after series C [bt·min^{-1}]	HR after 1 min rest after series C [bt·min^{-1}]	Index SJFT
M	5.30	9.70	9.30	24.30	175.00	129.00	12.60
SD	0.47	0.79	0.79	1.80	7.00	12.90	0.69

As it is evident from the presented data, the sum of all points in the IPFT test amounted to 534.4 pts, which, according to valuation regulations of the specified test, is regarded as an index of high total preparation (in accordance with the grading scale of this test, the values of 481 pts and above are considered as high).

To characterize the level of sport-specific preparation of female judo competitors on the basis of indices of the used tests is not possible because there is no appropriate grading scale for the SJFT test.

The analysis of results has shown that the studied athletes obtained an average value of the index (I_{SJFT}) – proving their achievement in SJFT at the level of 12.6±0.69. The number of throws in the shortest series (A) amounted to 5.3±0.47, while in the 30 s series B the number of throws was 9.7±0.79. A fall in the number of throws in the 30 s series C in comparison to the previous series (9.3±0.79) was observed. In total, athletes of the studied group performed 24.3±1.8 throws in the analysed test. The heart rate immediately after the test and after a 1 min break was 175±7.0 and 129±12.9, respectively.

The results of the studies revealed high and statistically significant correlation coefficients between morphological characteristics and the indices in IPFT running tests, whereas with power indices they were less pronounced (Table 4). Thus, the results in the running at 50 m closely correlated with female athletes' body weight (r=0.81), their BMI (r=0.80), absolute and percentage body fat content (r=0.79 and 0.72), absolute and percentage of fat-free body mass (r=0.74 and –0.73), as well as with absolute and percentage content of body fluid (r=0.74 and –0.74).

Similar to those were the correlation of somatic indices with results in the running at 800 m (with a body weight r=0.85; with BMI r=0.80; with FAT_{kg} r=0.84; with $FAT_{\%}$ r=0.73; with FFM_{kg} r=0.77; with $FFM_{\%}$ r=–0.73; with TBW_{kg} r=0.77 and $TBW_{\%}$ r=–0.73), as well as the result of the 4×10 m test (with weight r=0.91; with BMI r=0.87; with FAT_{kg} r=0.85; with $FAT_{\%}$ r=0.70; with FFM_{kg} r=0.86; with $FFM_{\%}$ r=–0.70; with TBW_{kg} r=0.85 and with $TBW_{\%}$ r=–0.70).

Of the IPFT power performance test only the index of the "*maximum amount of the trunk slopes from the supine position for 30 s*" test showed a statistically significant correlation with female judo competitors' body length (r=–0.76) as well as with the fat-free content in their body mass (r=–0.69).

It should be noted that in this group of subjects additional 18 correlation coefficients were revealed, whose

Table 4. Correlation matrix (coefficients *r*) reflecting the relationship of female judo competitors' general and sport-specific preparation indices with their age-somatic characteristics (the bold typeface marks the correlation coefficients with the level of significance at $p<0.05$).

Indices		Age-somatic characteristics										
		Experience (years)	Age (years)	Height (cm)	Weight (kg)	BMI	FAT (kg)	FAT (%)	FFM (kg)	FFM (%)	TBW (kg)	TBW (%)
IPFT test	50 m run (s)	–0.32	–0.37	0.54	0.81	0.80	0.79	0.72	0.74	–0.73	0.74	–0.74
	Standing long jump (cm)	0.24	0.29	–0.35	–0.50	–0.50	–0.45	–0.45	–0.48	0.44	–0.49	0.47
	800 m run (s)	–0.15	–0.13	0.62	0.85	0.80	0.84	0.73	0.77	–0.73	0.77	–0.73
	Dominant hand grip (kg)	0.24	0.20	0.59	0.60	0.51	0.50	0.43	0.64	–0.44	0.63	–0.46
	Flexed arm hang (s)	0.56	0.52	–0.24	–0.52	–0.57	–0.55	–0.56	–0.43	0.56	–0.43	0.58
	Shuttle run 4×10 m	–0.16	–0.19	0.62	0.91	0.87	0.85	0.70	0.86	–0.70	0.85	–0.70
	30 s sit-ups	–0.03	0.11	–0.76	–0.60	–0.41	–0.44	–0.27	–0.69	0.27	–0.69	0.28
	Slope trunk forward (cm)	–0.28	–0.37	–0.16	–0.19	–0.04	–0.13	–0.18	–0.03	0.18	–0.03	0.20
SJFT test	Series A	–0.08	0.08	–0.49	–0.60	–0.52	–0.38	–0.29	–0.68	0.28	–0.68	0.31
	Series B	0.30	0.50	–0.50	–0.50	–0.42	–0.36	–0.23	–0.59	0.23	–0.59	0.26
	Series C	0.23	0.46	–0.71	–0.50	–0.34	–0.29	–0.16	–0.67	0.16	–0.67	0.18
	Sum of three series	0.21	0.44	–0.66	–0.60	–0.47	–0.38	–0.25	–0.73	0.24	–0.73	0.27
	HRimm after series C	–0.35	–0.15	–0.53	–0.16	0.04	0.04	0.17	–0.34	–0.17	–0.34	–0.16
	HR after 1 min rest	0.21	0.36	–0.48	–0.29	–0.18	–0.09	–0.03	–0.46	0.03	–0.46	0.04
	ISJFT	–0.27	–0.38	0.30	0.51	0.51	0.46	0.37	0.49	–0.37	0.49	–0.40

values ranged from 0.50 to 0.62, but the lack of statistical significance ($p>0.05$) cannot render them significant.

Among the indices of special judo preparation in the SJFT test, 8 cases of statistically significant correlation between the number of throws and individual somatic indices were found, in particular:

- number of throws in series A with FFM_{kg} (r=–0.68) and with TBW_{kg} (r=–0.68);
- number of throws in series C with body length (r=–0.71), with FFM_{kg} (r=–0.67) and with TBW_{kg} (r=–0.67);
- total found of throws in three series with body length (r=–0.66), with FFM_{kg} (r=–0.73) and with TBW_{kg} (r=–0.73).

The features of interactions indicate a high degree of correlation (r>0.7) between individual somatic indices and the indices in tests of general and sport-specific preparation in this group of subjects, and they are shown in Figure 1.

Discussion

General and sport-specific preparation is given a prominent place in the process of top-level athletes' preparation. In sports theory and praxis it is considered that general and sport-specific preparation constitutes an indispensable condition for the development of motor skills as one of the most important factors determining the effectiveness of athletes' training and competition activities [3,16]. Somatic build, playing an important role in shaping motive structure, is one of the components of physical fitness. According to Szopa [17], being a substantial element of morphological build, the composition of body tissues conditions the current and potential motive skills.

Solving the research problem of the present study presumed not only determining somatic characteristics and the level of general and special physical fitness, but also studying correlations between them.

In assessment of somatic characteristics knowledge on body composition is essential. The applied method of bio-electric

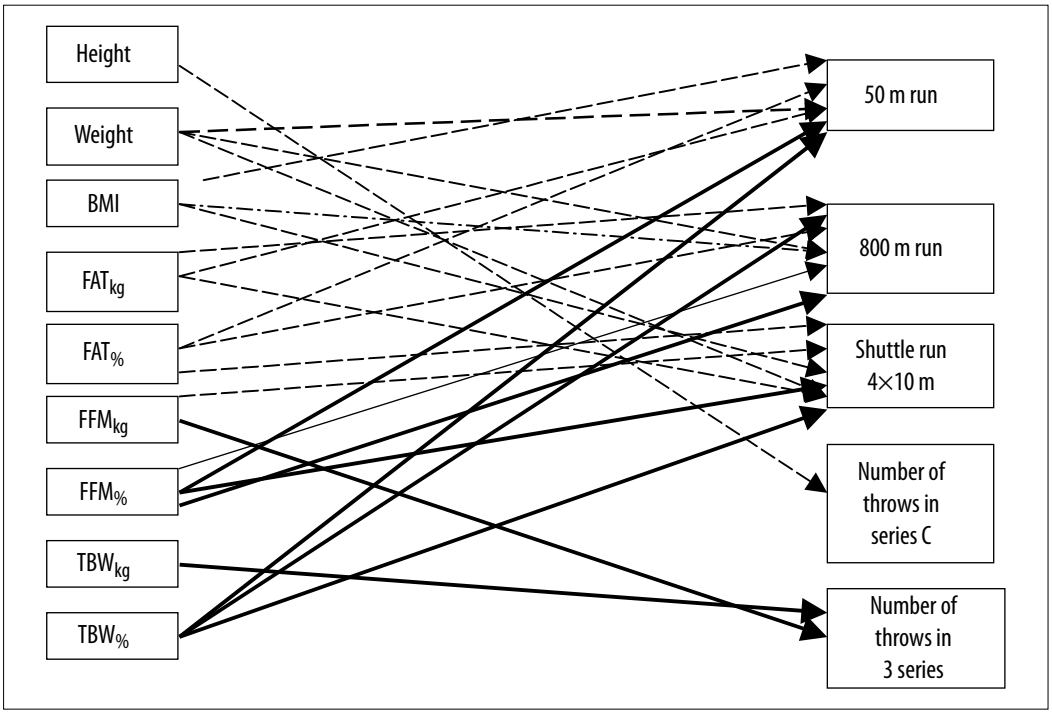

Figure 1. Interrelations indicating a high degree of correlation (r>0.7) between individual somatic indices and indices in tests of general and sport-specific preparation of the female judo competitors (n=11); ⟶ *direct correlation;* ⋯▸ *inverse correlation*.

impedance enabled the assessment of the ratio of metabolically active tissues to the fat tissue. To assess general physical fitness, the International Physical Fitness Test was used as it is widely applied in the training process of judo competitors. In consistence with the IPFT point scale (normative) ranges, the sum of points obtained by the studied athletes is considered to be an index of high general physical fitness. A similar situation was observed in the case of 16–18-year-old female competitors [18], whose integral index of general physical fitness amounted to 490.6 pts.

The results of a correlative analysis between somatic indices and achievements in IPFT allow asserting that female athletes who have lower body weight, smaller values of BMI, absolute and percentage values of the fatty component, the absolute indices of fat-free and liquid components of body mass, but a higher percentage of the latter two components, perform better in running tests.

In the case of IPFT power performance tests, it was found that female athletes who have smaller body length and lower absolute content of the fat-free component in it showed the best results.

The number of publications regarding results obtained from the application of SJFT among women is noticeably smaller than in the case of men. The value of the index proves the achievements in the SJFT test. According to the test author, lower values of the index indicate better achievements. The studied female athletes obtained the value of the index at the level of 12.6±0.69. In studies on Polish female athletes [19] the value of the index was 13.23±1.54, while in studies on Brazilian athletes [20] preparing to Pan-American Games the value of the index amounted to 13.09±1.55.

The results of the sport-specific fitness test (SJFT) achieved by Franchini et al. [20] regarding average group values of the heart rate immediately on completion of the test showed similar values to the ones in the present study (176±13 [bt·min^{-1}]). By contrast, the values of the heart rate indices after 1 min since completion of the test were markedly higher than in Brazilian competitors and amounted to 159±7 [bt·min^{-1}]. According to Franchini et al. [21], a decrease in HR at the end of the test with the given number of throws proves cardiovascular efficiency and a decrease in the same index after 1 minute since the completion of the test proves better regeneration and reflects an improvement in aerobic efficiency. A characteristic phenomenon of a fall in the number of throws in the last series of the SJFT test, confirming the growing fatigue process, was observed in Sterkowicz's research [19] as well as in Franchini's et al. [21].

As is known, indices of human motive development are largely determined by the level of parameters of somatic development [22]. That is why the question of the influence of body components on the level of physical fitness

seems justified. The results of correlations between somatic indices and achievements in SJFT allow asserting that female athletes who have smaller body length as well as lower absolute content of fat and liquid components in the body can do more throws in those series.

The presented data are considered from the standpoint of their significance and prospects for their use in future studies related to the problem of improving the effectiveness of the training process of the female judo competitors at different stages of long-term preparation.

Conclusions

1. The female judo competitors who have lower body weight, smaller values of BMI, absolute and percentage values of the fatty component, the absolute indices of fat-free and liquid component of body mass, but a higher percentage of the latter two components, perform better in all IPFT running tests.
2. Of the IPFT power performance test only the "*maximum amount of the trunk slopes from the supine position for 30 s*" index showed a statistically significant correlation with the female judo competitors' body length, as well as with the content of fat in their body mass. In this case female athletes who had smaller body length and lower absolute content of the fat-free component in it showed the best results.
3. The highly-qualified female judo athletes who had smaller body length as well as lower absolute content of fat and liquid components in the body demonstrate a higher level of sport-specific preparation in the SJFT test.

References:

1. Platonov WN: Общая теория подготовки спортсменов в олимпийском спорте. Киев: Олимпийская литература, 1997 [In Russian]
2. Anohin PK: Очерки физиологии функциональных систем. Москва: Медицина, 1975 [In Russian]
3. Matveev LP: Основы общей теории спорта и системы подготовки спортсменов. Киев: Олимпийская литература, 1999 [In Russian]
4. Jagiełło W: Теоретико – методические основы системы многолетней физической подготовки юных дзюдоистов. Studia i Monografie. Akademia Wychowania Fizycznego Józefa Piłsudskiego w Warszawie, Национальный университет физического воспитания и спорта Украины. Warszawa – Киев, 2002 [In Russian]
5. Jagiełło W: Budowa somatyczna kobiet trenujących judo. [In:] Kobieta jako funkcjonariusz porządku publicznego. Kalina RM, Łapiński P (eds.): Centralny Ośrodek Szkolenia Służby Więziennej. Kalisz, 2008; 160–65 [in Polish]
6. Orkwiszewska A, Smaruj M, Adam M: Budowa i skład ciała judoków. [In:] Kuder A, Perkowski K, Śledziewski D (eds.): Kierunki doskonalenia treningu i walki sportowej – diagnostyka. Warszawa, AWF, 2006, III: 122–23 [in Polish]
7. Kuźmicki S, Jagiełło W: Niektóre różnice i podobieństwa w budowie ciała judoków. [In:] Kalina RM, Jagiełło W (eds.): Wychowawcze i utylitarne aspekty sportów walki. Warszawa, AWF, 2000 [in Polish]
8. Jagiełło W, Kalina RM, Tkaczuk W: Morphological differentiation of judo competitors. [In:] Szopa J, Gabryś T (eds.): Sport training in interdisciplinary scientific researches. Częstochowa: Faculty of Management Technical University of Częstochowa, 2004; Chapter II: 200–6
9. Jagiełło W, Kalina RM, Korobielnikow G: Morphological diversification of female judo athletes. Archives of Budo, 2007; 3: 27–34
10. Jagiełło W, Witkowski K: Wpływ wybranych wskaźników somatycznych na szkolenie judoków wysokiej klasy. [In:] Sterkowicz S (ed.): Czynności zawodowe trenera i problemy badawcze w sportach walki. Kraków, AWF, 2001; 62–71 [in Polish]
11. Marachocka M: Budowa ciała a preferowane techniki walki judo. Sport Wyczynowy, 1988; 9(285): 25–31 [in Polish]
12. DuBois D, DoBois EF: A formula to estimate the approximate surface area if height and weight be known. Arch Intern Medicine, 1916; 17: 863–87
13. Iwanek B, Rogowska E: Antropologia. Materiały do ćwiczeń. AWFiS, Gdańsk, 2004 [in Polish]
14. Pilicz S, Przewęda, Dobosz J, Nowacka-Dobosz S: Punktacja Sprawności Fizycznej Młodzieży Polskiej wg Międzynarodowego Testu Sprawności Fizycznej. Kryteria Pomiaru Wydolności Organizmu Testem Coopera. Studia i Monografie. Warszawa, AWF, 2002 [in Polish]
15. Sterkowicz S: Test specjalnej sprawności ruchowej w judo. Antropomotoryka, 1995; 12–13: 29–44 [in Polish]
16. Kalina RM: Teoria sportów walki. Warszawa, COS, 2000 [in Polish]
17. Szopa J: Zmienność ontogenetyczna, zróżnicowanie środowiskowe oraz genetyczne uwarunkowania rozwoju komponentów ciała w populacji wielkomiejskiej w wieku 7–62 lat. AWF, Kraków, 1985 [in Polish]
18. Jagiełło W, Wolska-Paczoska B, Smulski W: Physical preparation of female judo competitors at selected stages of long-standing sports training. Archives of Budo, 2009; 5: 47–53
19. Sterkowicz S: Specjalna sprawność ruchowa. Proceedings of The Fourth International Conference Sex Dimorphism in Sport. Katowice, 1997; 188-95
20. Franchini E, Matsushigue KA, Kiss MAPD, 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
21. Franchini E, Nakamura FY, Takito MY et al: Anállise de um teste especifico para o judô. Revista Kinesis, 1999; 21: 91–108
22. Karpowicz K, Karpowicz M, Strzelczyk R et al: Somatyczne uwarunkowania poziomu sprawności fizycznej młodych koszykarzy. [In:] Kuder A, Perkowski K, Śledziewski D (eds.): Proces doskonalenia treningu i walki sportowej. Warszawa, AWF, 2005; II: 101–4 [in Polish]