

The correlation of general and special physical fitness indices with body weight and composition 13-16 year-old female judo athletes

Authors' Contribution:

- ☑ **A** Study Design
- ☑ **B** Data Collection
- ☑ **C** Statistical Analysis
- ☑ **D** Manuscript Preparation
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Beata Wolska^{1ABCDE}, Marek Adam^{1ABDE}, Piotr Klimowicz^{2CD}

¹ Gdansk University of Physical Education and Sport, Department of Combat Sports, Gdansk, Poland

² Centre for Physical Education and Sport, Bialystok University of Technology, Bialystok, Poland

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Abstract

Background & Study Aim:

At the stage of comprehensive training of juvenile judo athletes physical fitness, weight and body composition are subject to factors both natural biological development, as well as the strong influence of training loads. The study aims is the correlation between general and special physical fitness indices and somatic indices in 13–16 year-old female judo athletes.

Material & Methods:

Fourteen female judo athletes of the provincial team of Pomerania (in Poland) in the group of youngsters and younger juniors were subject to examination. The subjects' mean age was 13.9 ± 1.1 years and the average training experience 5.5 ± 1.9 years. To determine the somatic characteristics: the weight and body composition in the form of adipose tissue (FAT), lean body mass (FFM), body water (TBW) – the Tanita Body Composition Analyzer was used. To assess general physical fitness was applied International Committee on the Standardisation of Physical Fitness Test (ICSPFT). The level of special effort capacity was assessed by means of Special Judo Fitness Test (SJFT) and the Igumienov's test.

Results:

The results of a correlative analysis between somatic indices and ICSPFT achievements did not reveal a single correlation indicating a very high level of interdependence. It was observed that lower values of the body height, FAT (kg), FAT (%) and higher values of FFM (%) and TBW (%) corresponded to lower HR values after 1 minute since completion of the SJFT test, which suggests faster restitution after a specific load related to performing the test.

Conclusions:

The examined female judoists were characterized by high indices of general physical fitness, which could prove that judo is an appropriate measure to stimulate comprehensive physical development of youth.

Key words:

Igumienov test • physical preparation • Special Judo Fitness Test • stage of training • training load

Author's address:

Beata Wolska, Gdansk University of Physical Education and Sport, Górskiego 1, 80-336 Gdansk, Poland; e-mail: beata.wolska@wp.pl

Position – noun 1. the place where a player is standing or playing 2. the way in which a person's body is arranged [46].

Posture – noun the position in which a body is arranged, or the way a person usually holds his or her body when standing [46].

Seoi nage – back throw in judo.

Training load – “A simple mathematical model of training load can be defined as the product of qualitative and quantitative factor. This reasoning may become unclear whenever the quantitative factor is called ‘workload volume’ or ‘training volume’ interchangeably with ‘volume of physical activity’. Various units have been adopted as measures i.e. the number of repetitions, kilometres, tons, kilocalories, etc. as well as various units of time (seconds, minutes, hours) (...) As in the real world nothing happens beyond the time, the basic procedure of improvement of workload measurement should logically start with separation of the time factor from the set of phenomena so far classified together as ‘workload volume’. (...) Due to the fact that the heart rate (HR) is commonly accepted as the universal measure of workload intensity, the product of effort duration and HR seems to be the general indicator of training load defined as the amount of workload. It is useful in analyses with a high level of generality. (...) In current research and training practice the product of effort duration and HR was referred to as conventional units’ or further calculations have been made to convert it into points.” [45, p. 238].

INTRODUCTION

One of the primary tasks in the process of sports training is to achieve an appropriate level of motor skills and of the functional capacity of the body, which are responsible for providing for effort in a given sport discipline. Implementation of this task is carried out within the framework of physical preparation ensuring the shaping of both general and specific fitness and its manifestation under conditions of competition. Significant changes to the content and the proportion of different aspects of an athlete's preparation take place during its multi-year stages [1-5]. Each stage has quite a clearly defined assumption and goals, but also health mission (choice of sport / sports life, which according to the formula of sport for all each person can practice well up to advanced years [6-15]).

The first stage is characterized by a predominance of general preparation, aimed at shaping an optimal foundation for future mastery. Individual prospects of sports achievements are primarily conditioned by full-featured physical and mental development of an athlete, the general level of his functional capabilities on par with a systematic development of individual knowledge, skills and habits. The whole further progress and results of many-year sporting activity largely depend on to what extent this base is provided at the first stage. Then, as sports specialization deepens (e.g. judo [16-19]), the importance of special preparation, focused on the shaping and improvement of the level of training in a chosen sport discipline accordingly increases [1-4].

Tissue components of the body is a significant element of the morphological composition conditions the current and potential motor skills [20]. In recent years, a significant amount of information has been collected, among others, on determining judoists' overall body build and the tissue composition as well as on defining the degree of dimorphic differentiation of somatic features in top class judo competitors [21-25]. They were also explored issue of interdependence of morphological determinants and the sport activity of female [25] and male [26] Polish judo representatives and on searching for correlations between the body composition and the applied

techniques [27]. The information collected so far does not fully meet the needs connected with defining the correlations of physical fitness indices with somatic indices, particularly in the group of athletes at the comprehensive stage of training. At the stage of comprehensive training of juvenile judo athletes physical fitness, weight and body composition are subject to factors both natural biological development, as well as the strong influence of training loads.

The study aim is the correlation between general and special physical fitness indices and somatic indices in 13–15-year-old female judo athletes.

MATERIAL AND METHODS

Participants

Fourteen female judo athletes, aged 13-16 year-old (at the stage of comprehensive training), provincial team contestants of Pomerania (in Poland) from the group of youngster and younger junior were subject to research. The subjects' mean age was 13.9 ± 1.1 years (7 in 13-, 2 in 14-, 4 in 15-, 1 in 16 year-old), and the mean training experience 5.5 ± 1.9 years (minimum 3, maximum 9). The study was conducted at the Combat Sports Department and in the Laboratory of Functional Diagnostics at Gdansk University of Physical Education and Sport (Polnad) at the beginning of the preparatory period, in which the athletes were not involved in the regulation of body weight. All the tested athletes had current sports medical examinations. A written consent of the athletes and their parents was obtained to participate in effort tests.

Somatic characteristics

Somatic characteristics were based on the body height and indices characterising its mass and composition. The body height was measured by means of an anthropometer produced by the Lublin Factory of Weights in Poland (reg. no. 37996) to the nearest 1 mm. The body weight and body composition in the form of adipose tissue (FAT), lean body mass (FFM) and body water (TBW) were measured by means of the Tanita Body Composition Analyser TYPE TBF-410 MA III (Japan). The Quetelet II index (BMI) [kg · m⁻²] was also calculated (Table 1).

Table 1. The somatic indices 13-16 year-old female judo athletes (n = 14) – mean results in bold type.

Body height (cm)	Body mass (kg)	BMI	FAT (kg)	FAT (%)	FFM (kg)	FFM (%)	TBW (kg)	TBW (%)
164.1 ±7.4	54.4 ±6.9	20.2 ±2.1	12.2 ±4.6	22.0 ±5.9	42.1 ±3.9	78.0 ±5.9	30.8 ±2.8	57.6 ±5.1

General physical fitness

To assess general physical fitness, the International Committee on the Standardisation of Physical Fitness Test (ICSPFT) was applied and conducted on two consecutive days. The conversion of results obtained in the particular tests was made on the basis of tables according to groups of the calendar age [28].

Special physical fitness

To assess the special effort potential, the Special Judo Fitness Test (SJFT) was applied [29]. It consists of three work periods: 15 s (series A), 30 s (series B), 30 s (series C) separated by 10-sec intervals. During each effort the subject's task was to perform as many *seoi nage* throws with two partners of the same weight category and with similar body height, who were standing 6 meters away from each other, while the subject took position in the middle between them. Directly after the end of series C and after 1 minute since completion of the test, the heart rate (HR) was measured, for which a POLAR 810i™ heart rate monitor (Finland) was used.

The number of throws in each series and the total number of throws were recorded. On the basis of the obtained results, the following index (lower represented better results) was calculated:

$$\text{SJFT Index} = \frac{\text{Final HR (bpm)} + \text{HR 1 min (bpm)}}{\text{throws in total (N)}}$$

where:

Final HR – heart rate recorded immediately after the test.

HR1 min – heart rate obtained 1 minute after test.

Throws – number of throws completed during the test.

To evaluate the subjects' special effort potential, also another tool was used: Igumienov Test [30]. The test consists of three sections of work separated by 1-minute break. During each series of the test, the subject's task was to perform 15 *seoi nage* throws in the shortest possible time. The throws were executed with three partners of the same weight category, positioned behind one another. Before the first throw of each series, the athletes were standing at a distance of extended arms from each other in the position (posture) ready for *seoi nage*. Each test series was initiated by the command *hajime* (forward) and ended with the command *mate* (interrupt fighting). During the test, the time of executing 15 throws in each series, the sum of times of all series, the heart rate immediately after completion of the test, and after 1 minute since the end of the test were recorded. To determine the test results, the total time of three test series was taken into consideration.

Statistical analysis

Statistical analysis was conducted with a use of STATISTICA 7.0. The arithmetic mean, the standard deviation and Pearson's correlation coefficients (r) were calculated.

RESULTS

According to the obtained data, 13-16-year-old female judoists were characterised by high levels of general physical fitness – the average value of the total score all trials is 513 points (Table 2). However, the test result of less than 481 points (the criterion of high level) has 2 female judo athletes (14%).

The tested athletes obtained the average value of the Index SJFT – proving their achievements in SJFT at the level of 15.2 ± 1.51 (Table 3). The number of throws in the shortest series A amounted to 4.7 ± 0.61 ,

Table 2. General physical fitness indices based on the ICSPFT 13-16 year-old female judo athletes (n = 14) – arithmetic mean in bold type.

50 m sprint (s)	Standing long jump (cm)	800 m race (s)	Grip strength (kg)	Flexed arm hang (s)	4x10 m shuttle run (s)	Sit-ups 30 (number)	Forward bend (cm)
7.99 ±0.51	199 ±17.1	199.7 ±21.2	29.5 ±7.8	17.2 ±9.8	10.71 ±0.82	32.1 ±3.5	16.7 ±5.1
Points (total 513: minimum 438, maximum 575)							
62.4 ±7.2	67.8 ±8.6	61.8 ±5.9	60.4 ±15.5	56.9 ±7.2	65.4 ±6.3	70.8 ±7.5	66.5 ±11.3

Table 3. Special physical fitness indices based on the SJFT 13-16 year-old female judo athletes (n = 14) – arithmetic mean in bold type.

Number of throws in series:			Sum of throws in three series	HR (bt · min ⁻¹)		SJFT Index
A	B	C		after effort	1 min after effort	
4.7 ±0.61	9.3 ±0.93	8.8 ±0.8	22.9 ±2.01	191 ±4.8	153 ±10.2	15.2 ±1.51

while in the 30-second series B 9.3 ±0.93. A decline in the number of throws in the 30-second series C was noted in comparison to the previous series (8.8 ±0.8). In total, the competitors performed 22.9 ±2.01 throws on average. The heart rate immediately after completion of the test and after 1-minute break was 191 ±4.8 and 153 ±10.2, respectively (Table 3).

In the Igumienov Test the execution time of 15 throws in each successive test series was shorter: from 27.9 ±3.3 seconds in series A to 25.7 ±4.3 seconds in series C (Table 4). Heart rate after effort in both tests (SJFT and Igumienov) it indicates a very similar intensity load. Female judo athletes slightly better tolerate exercise after the Igumienov Test.

From among ICSPFT indices (Table 5), the results of the sit-up test showed a high statistically significant (p<0.01) negative correlation with the level of adipose tissue FAT (kg) r = -0.66 and FAT (%) r = -0.67, as well as a positive correlation with the percentage content of lean body mass (FFM) r = 0.67 (p<0.01) and the total amount of water in the body (TBW) r = 0.56 (p<0.05).

This was similar in the case of correlations between special fitness test indices and somatic indices. Only one of the special fitness test (SJFT) indices, namely, the heart rate (HR) after 1 minute since completion of the test, showed a significant correlation with the majority of somatic indices. The strongest relationships regarded: (HR) after 1 minute since completion of the test with body height (r = -0.57, p<0.05),

BMI (r = -0.70, p<0.01), FAT (kg) (r = -0.65, p<0.05), FAT (%) (r = 0.67, p<0.01), FFM (%) (r = 0.67, p<0.01) and TBW (%) (r = 0.56, p<0.05).

From among the Igumienov’s test indices, the time of executing 15 throws in series A and the heart rate immediately after completion of the test highly negatively correlated (p<0.05) with the subjects’ age: (r = -0.64) and (r = -0.59).

DISCUSSION

The research problem of the present study required not only determining the level of somatic characteristics and the level of general and special physical fitness, but mainly finding correlations between them. The results of the ICSPFT have shown that, in accordance with the point brackets, the total score obtained by the subjects (513 points) is defined as a high index of general physical fitness. The results of a correlative analysis between somatic indices and achievements in the ICSPFT did not reveal a single correlation indicating a very high level of dependency (r ≥ 0.7).

ICSPFT application (in some publications briefly called the Test of Physical Fitness or TPF [31]) in many previous judo athletes studies (using all 8 trials [31-35] or in part [36]) creates the basis for tracking longer periods of two groups of phenomena. The first is the potential motor (energy) of young people starting judo trainings. Another change under the general physical fitness under the influence of long-term impact of specific judo training loads.

Table 4. Special physical fitness indices based on Igumienov Test 13-16 year-old female judo athletes (n = 14) – arithmetic mean in bold type.

Time of 15 throws (s) in series:			Total time in three series (s)	HR (bt · min ⁻¹)	
A	B	C		after effort	1 min after effort
27.9 ±3.3	26.4 ±3.2	25.7 ±4.3	80.0 ±10.3	189 ±6.9	143 ±11.2

Table 5. Correlations between general physical fitness (ICSPFT) and special physical fitness (SJFT and Igumienov Test) indices and the age and somatic indices female judo athletes (n = 14).

Somatic indices	Age (years)	Body height (cm)	Body weight (kg)	BMI	FAT (kg)	FAT (%)	FFM (kg)	FFM (%)	TBW (kg)	TBW (%)
ICSPFT										
50 m dash (s)	-0.38	0.02	-0.01	0.03	0.17	0.18	-0.17	-0.18	-0.16	-0.14
Standing brad jump (cm)	0.15	-0.04	0.45	-0.42	-0.25	-0.31	0.23	0.30	0.23	0.32
800 m run (s)	0.11	0.19	0.40	-0.08	0.08	0.03	0.24	-0.03	0.25	-0.04
Hand grip (kg)	0.02	0.40	0.29	0.26	0.16	0.03	0.52	-0.03	0.52	0.01
Bent arm hang (s)	0.26	-0.07	0.09	-0.18	-0.17	-0.20	0.08	0.20	0.07	0.13
4 x10 m shuttle run (s)	-0.45	0.41	0.18	0.35	0.50	0.46	0.14	-0.46	0.14	-0.47
Sit ups (number)	0.15	-0.55	-0.22	-0.51	-0.66**	-0.67**	-0.18	0.67**	-0.19	0.56*
Bend truk (cm)	0.11	0.10	0.07	0.07	0.24	0.33	-0.10	-0.33	-0.10	-0.43
SJFT										
Number of throws in series A	-0.24	-0.19	-0.35	0.04	-0.18	-0.15	-0.13	0.15	-0.13	0.18
Number of throws in series B	-0.08	-0.15	-0.26	0.02	0.02	0.09	-0.30	-0.09	-0.30	-0.11
Number of throws in series C	0.28	-0.34	-0.14	-0.31	-0.22	-0.13	-0.36	0.13	-0.36	0.13
Total throws	0.00	-0.26	-0.27	-0.10	-0.13	-0.05	-0.31	0.05	-0.31	0.06
HR after effort (bt · min ⁻¹)	-0.02	-0.04	0.04	-0.09	-0.15	-0.22	0.10	0.22	0.11	0.20
HR 1 min after effort (bt · min ⁻¹)	0.23	-0.57*	-0.05	-0.70**	-0.65*	-0.67**	-0.24	0.67**	-0.24	0.56*
Index SJFT	0.04	0.06	0.26	-0.15	-0.08	-0.16	0.21	0.16	0.21	0.11
Igumienov Test										
Time of 15 throws in series A	-0.64*	-0.07	-0.12	0.00	0.13	0.21	-0.29	-0.21	-0.29	-0.07
Time of 15 throws in series B	-0.39	0.11	0.18	-0.02	0.10	0.09	0.09	-0.09	0.09	0.05
Time of 15 throws in series C	-0.53	0.20	0.19	0.07	0.26	0.27	0.06	-0.27	0.06	-0.07
Total time in three series	-0.55	0.10	0.10	0.02	0.18	0.21	-0.04	-0.21	-0.04	-0.04
HR after effort (bt · min ⁻¹)	-0.59*	-0.19	-0.36	0.04	0.02	0.07	-0.36	-0.07	-0.36	0.09
HR 1 min after effort (bt · min ⁻¹)	-0.17	-0.08	0.34	-0.41	-0.14	-0.17	0.01	0.17	0.02	0.28

* p<0.05 ** p<0.01

An analysis of the relationship between somatic indices and the special fitness test indices revealed that only the heart rate after one minute since completion of the SJFT very highly negatively correlated with the BMI. It follows from the presented data that lower values of the body height, FAT (kg), FAT (%) and higher values of FFM (%) and TBW (%) corresponded to lower values of the HR after 1 minute since completion of the test, which suggests faster recovery after a specific load related to performance of the test.

The nature of the relationships between somatic indices and indices of general and special physical fitness in a group of top level athletes [37] and 16-18 year-old athletes [38] was inconsistent. Taking into account only the values of correlation coefficients which show a very high degree of relationships between the studied indices ($r \geq 0.7$), it has been proved that in the group of seniors [37] they were manifested in 28 cases, in the group of 16-18 year-old athletes [38] in 6 cases, while in the group of 13-16 year-old athletes in only one. On the basis of the above reports, one can argue that a high value of particular somatic

indices, essential in achieving a high level of general and special physical fitness by the examined athletes, has been determined.

The results of own research has shown that 13-16 year-old female judoists obtained the SJFT Index value at the level of 15.2 ± 1.51 . Lower values of the index, proving better achievements in SJFT, were reported in Sterkowicz's study [39] conducted in a group of Polish juniors (13.23 ± 1.54), but much higher in a group of Brazilian juniors (17.59 ± 1.40) [40]. In Sogabe's et al. study [41] on Japanese female contestants (aged 17.2 ± 2.3 years), the index amounted to 12.50 ± 1.30 , and in Polish representatives in the group of seniors 12.6 ± 0.69 [37]. The results of the special fitness test (SJFT) obtained by Sogabe et al. [41] concerning the heart rate immediately after completion of the test revealed lower values than in the presented study (191 ± 4.8 HR) and amounted to 182.3 ± 7.2 HR, while HR after 1 minute since completion of the test 152.1 ± 12 HR, so similarly to the group of 13-15 year-old athletes (153 ± 10.2 HR). In the SJFT test, ju jitsu athletes obtained the index value at the level of 13.84 ± 2.60 , while the heart rate immediately after completion of the test was 191 ± 27 HR, and after one minute since completion of the throws it was 153.3 ± 25.4 HR [42].

As regards the classification of the Special Judo Fitness Test [43] for female junior age judoists, the

13-16 year-old female athletes (youngsters/younger juniors) tested in this study received the index value in the average range.

The number of publications on the results achieved by the application of the Igumienov test is far lower than in the case of SJFT. Jagiełło et al. [44] in their study showed that female athletes of the highest sports level needed 71.8 ± 11 seconds to execute the specified number of throws, which is far less than proved in the presented research on the group of youngster and younger junior female athletes.

CONCLUSIONS

The studied female athletes were characterized by high indices of general physical fitness, which could prove that judo is an appropriate measure to stimulate comprehensive physical development of youth.

The results of the present study may prove useful in the sports selection process conducted both within the framework of selection and sports orientation and within the framework of particular weight categories at a later stage of long-term sports training.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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