

Special fitness testing in sport ju-jitsu

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:

Ability to diagnose fitness-related preparation is essential for sport coaches. The goal of this work is to analyse the results of special motor fitness testing among the group of participants of *ju-jitsu* coaching course and determination of individual fitness profiles.

Material/Methods:

14 coaches qualified by Polish Ju-jitsu Association participated in the coaching course at which the investigations were carried out. Age and experience in *ju-jitsu* among the investigated coaching staff were 35.6 ± 8.6 and 16 ± 8.0 years old, respectively. They showed high-level fighting skills: 4–6 Dan ($n=5$), 1–3 Dan ($n=5$), 1 Kyu ($n=4$). The investigated persons performed eight fitness trials according to the instructions concerning the battery of tests employed in karate (*SPFT*) and judo (*SJFT*). Descriptive statistical methods were used for elaboration of the results.

Results:

Using cluster analysis, three groups of tests were found to characterize special physical fitness among *ju-jitsu* coaches. Cluster 2 integrated the results of tests employed both in karate and judo. Individual characteristics were described. Moreover, the results of the present work prove that practicing martial arts by middle-aged persons maintains certain motor, fitness and coordination abilities and skills, useful for self-defence and satisfying human need for security.

Conclusions:

Trained coaches represent different level of motor abilities essential in *ju-jitsu*. Integration of special motor abilities takes place in three clusters, forming motor competence of coaching staff. Special fitness tests are suitable for control of *ju-jitsu* sport training since they do not require advanced equipment and are easy to be performed.

Key words:

ju-jitsu • physical fitness • components • tests • coaching

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BACKGROUND

In opinions of majority of sport theorists, motor fitness can be broken into general and special fitness. General fitness encompasses basic motor abilities i.e. strength, speed and endurance. Additionally, certain coordination abilities are also frequently mentioned [1]. A particular contribution to measurement of these abilities is from body build, including flexibility expressed in the movement range. General fitness tests focus on the data about the level of individual motor abilities. Special ability tests are applied for assessment of the fitness in a particular discipline of sport [2]. General fitness preparation can be examined by means of well-known tests, such as *International Physical Fitness Test IPFT* [3] or *EUROFIT* [4].

Special fitness tests might be employed in a particular discipline of sport since they focus on technical elements characteristic of the sport.

As results from observation of sport **ju-jitsu** championships, both elements typical of karate and judo are used during fighting [5]. Ju-jitsu is a fighting sport that combines both karate and judo techniques. In ju-jitsu fightings, which are held in six weight categories, there are three phases: 1. exchange of punches and kicks (as in karate), 2. Opponent throws after clothes grip (similar to judo), 3. Grips in horizontal posture (grips, strangles, and joint locks). After evaluation of action in second and third phase, the fight is resumed in first phase [6]. Techniques most often used during phase I included

Ju-jitsu – a contemporary sport, which emphasise the all round development of schooling.

punches and *Mae-geri* (front kicks) as well as *Mawashi-geri* (round kicks). During phase 2, *Te-waza* (hand techniques) prevailed (throws) The most frequent were *Seoi-nage* (shoulder throws). They belong to a group of techniques which are characterised by performing half-turn during *Tsukuri* balance-breaking and maintenance of two-leg balance during an action to setup a throw *Kuzushi*. In phase 3, where pinning techniques *Osaekomi-waza*, (joint techniques) *Kansetsu-waza* and strangling techniques *Shime-waza* are allowed – scarf-hold *Kesagatame* and cross lock *Ude-hishigi-juji-gatame* prevailed [5]. The fighting took place in two-minute rounds separated with 1-minute rest. After scores are assigned by the referees in each round, in second and third phase, fighting is resumed from phase 1 [6].

Physical fitness – the ability of a person to function efficiently and effectively [13].

Components of physical fitness – health-related components of physical fitness include body composition, cardiovascular fitness, flexibility, muscular endurance and strength. Skill-related components include agility, balance, coordination, power, reaction time, and speed [13].

Tests – an examination designed to reveal the relative standing of an individual in a group [7].

Coaching – is the organised provision of assistance to an individual performer or group of performers in order to help them develop and improve in their chosen sport. Coaching therefore involves instruction, teaching and training, but also has additional distinctive features [14].

Physical fitness testing among the contestants is undoubtedly one of the most essential objectives to improve professional activities of sports coaches. For control of training effects, special fitness tests have been so far verified in karate [7] and judo [8]. In consideration of similarities of ju-jitsu and karate (phase 1 of the fight) and judo (phase 2 and 3 of the fight), it was assumed that the battery of tests for karate *SPFT* and judo *SJFT* can be used for assessment of special fitness preparation among ju-jitsu coaching staff. Coaches, after familiarizing themselves with testing methods, can periodically implement them in their sports clubs where they coach or among national team members.

The goal of this work was (a) to analyse the results of special motor fitness testing among the group of participant of the coaching course and (b) to determine individual fitness profiles.

MATERIAL AND METHODS

Participants

Twenty persons took part in the coaching course conducted at the University School of Physical Education. These persons were active coaches qualified by Polish Ju-jitsu Association. All of them had to present a valid health certificate of physical fitness and expressed their consent to participate in physical fitness examinations. The interview on their age, experience and degree of advancement in *ju-jitsu* was made and then basic anthropometric measurements (height, weight) were taken and recorded in special individual reports.

Table 1. General characteristics of test participants.

Statistics	Age (years)	Experience (years)	Height (cm)	Body weight (kg)	BMI (kg/m ²)
Average	35.6	16.0	172.2	72.3	24.2
Standard deviation	8.55	8.02	6.45	13.65	3.40

General characteristics of 14 men who were able to perform all the fitness tests are presented in Table 1.

Age and experience in *ju-jitsu* among the examined coaching staff was considerably varied (from 22 to 52 years old and 4 to 27 years, respectively). Their *ju-jitsu* skills level was also different: 1 Kyu (n=4), 1–3 Dan (n=5), 4–6 Dan (n=5).

Body height was within the range of 164 to 187 cm, while body weight amounted to from 49.6 to 103 kg. Body mass index values proved that the average was within the standard of BMI <24.99 kg/m²). However, SD values show that the overweight persons prevailed in the examined group of persons (BMI ≥25 kg/m²).

Testing tools

Fitness trials were performed according to the procedures of the battery of tests used in karate *SPFT* [7,9] and judo *SJFT* [8]. They encompassed:

1. *Hip turning speed test* (s).
2. *Speed punches test* (s).
3. *Flexibility test* using *Mawashi-geri* kick (cm). Flexibility index = maximum range of kick/body height.
4. *Rapid kicks test* (s).
5. *Agility test* (s).
6. *Evasive action test* (s).
7. *Push-ups* with one hand clapping at one second (maximum repetitions – n)
8. *Special Judo Fitness Test (SJFT)* – number of throws, Heart rates per minute (bpm) and Index in *SJFT*.

Statistics

During preparation of the results, descriptive statistical methods were employed. The arithmetic mean (\bar{X}), standard deviation (SD) were calculated, as well as standardized values (z) for each test result (xi), according to the formula: $z = (xi - \bar{X}) / SD$. In order to recognize the structure of special motor fitness in ju-jitsu, furthest neighbour method and city-block distance were employed for cluster analysis. Sunray plot was then designed to display the results of special ju-jitsu fitness tests on a case-by-case basis. This plot was used to identify outstanding cases.

The calculations were performed using STATGRAPHIC Centurion XV software in Department of Theory and

Table 2. Results for testing of *Hip turning*, speed punches, flexibility and flexibility index.

Statistics	Hip turning (s)	Speed punches (s)	Flexibility (cm)	Flexibility index
Average	11.42	10.32	163.4	0.94
Standard deviation	0.91833	2.10545	20.54	0.12

Table 3. Results for testing of *Rapid kicks*, agility, evasion actions and push-ups.

Statistics	Rapid kicks (s)	Agility (s)	Evasion actions (s)	Push-ups (reps)
Average	19.12	16.53	43.63	28.86
Standard deviation	2.52	2.00	3.49	14.18

Table 4. Number of throws performed in *SJFT*.

Statistics	Series A (15s)	Series B (30s)	Series C (30s)	Total throws
Average	5.1	9.1	8.4	22.7
Standard deviation	0.36	0.66	0.65	1.38

Table 5. Heart rates and Index in *SJFT*.

Statistics	HR after	HR 1 min after	HR sum	Index
Average	179.9	158.1	337.9	14.91
Standard deviation	13.6	13.2	24.3	1.22

Methodology of Combat Sports at University School of Physical Education.

RESULTS

a. Characteristics of special motor fitness

Tables 2–5 compares results of special fitness tests among *ju-jitsu* coaches.

Average exercise duration time for *Turning hips speed*, *Speed punches*, *Rapid kicks*, *Agility*, *Evasion actions* trials and duration time for Series A in *SJFT* ranged from 10.3 to 43.6 s.

These efforts are based mainly on anaerobic exercise and provide a measure of special speed. Undoubtedly, response time, frequency of repetitions and level of movement mastery are essential for the obtained results. *The shortest tests* were *Turning hips* and *Speed punches*, whereas *Evasion actions* test called for speed endurance. Local strength endurance was tested by *Push-ups* test with one hand clapping at one second was assessed without pre-set time limit. This test showed great differentiation in terms of a number of repetitions (ranging from 5 to 54 repetitions).

During *SJFT* tests, exercises were broken with 10-s rest separating A and B series as well as B and C series. Total time for *SJFT* takes 1 minute and 35 seconds. Multiplication of the results from A series by two (giving average of

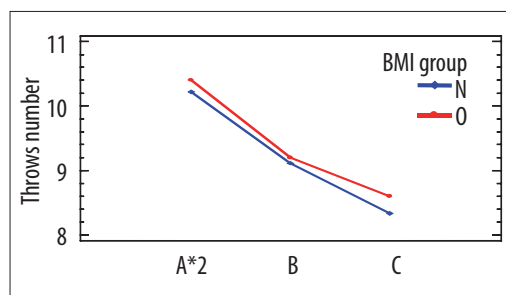


Figure 1. Mean number of throws in each series of *SJFT* (N – normal weight (n=9), O – overweight, n=5).

series A2 = 10.2 throws) proves considerable drop in the number of throws in series B and C, which is a consequence of deepened fatigue ($F=49.84, p<0.001$). This phenomenon not depend on BMI of coaches ($F=1.36, p>0.05$) (Figure 1).

SJFT index points to the level of fitness. ‘HR after’ value reflects intensity of internal load during *SJFT* while ‘HR 1 min after’ shows efficiency of recovery process. In well-trained individuals, heart rate dropped to normal state much faster while in less trained, high heart rate was maintained over a longer period of time. A greater value of the index indicates lower physical fitness among the examined participants.

Additional calculations did not reveal any statistically significant correlations between the results of the conducted special fitness tests and age, training experience and BMI among *ju-jitsu* coaches. Fitness tests results

were not correlated with each other with the exception of Evasion actions and Index in *SJFT* ($r=0.54, p<0.05$).

b. Structure of special fitness among coaches

Figure 2 illustrates clusters based on motor effects registered in individual *SKFT* and *SJFT* tests (standardized values). The dendrogram shows how each cluster is formed. A horizontal line connecting two groups shows that the groups were combined at the distance shown on the vertical axis.

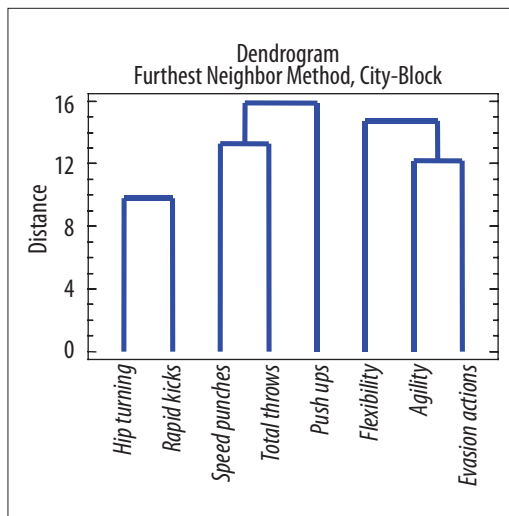


Figure 2. Structure of special physical fitness among ju-jitsu coaches.

Three groups of tests which characterize special physical fitness in *ju-jitsu* coaches were divided in the dendrogram. In first stage, the results of *Hip turning* speed test (movements useful for both attacks and self-defence) and *Rapid kicks* are connected. Their common element is undoubtedly *Hip turning* movement as it is impossible to perform *Mawashi-geri* (kick without turning hips).

A cluster containing *Speed punches* test and *Total throws* in *SJFT* can be observed in the centre of dendrogram. It also shows that the next stage at which this combined group was further combined with another cluster was *Push-ups* test. *Speed punches* open up an opportunity to grip clothes and perform throws. The opponent can be also pushed to prevent him from clinching.

It is remarkable that this cluster integrates motor effects manifested in actions with upper limbs (fist punches, pushing with hands, hand throwing techniques).

The cluster on the right of dendrogram is formed by *Agility* test and *Evasion actions* test, also connected with *Flexibility* test. This cluster contains the methods of moving to the front and back which appear during fighting.

Coordination basis is formed by spatial orientation and dynamic balance (in both *Flexibility* and *Agility* tests exercises are performed standing on one leg).

c. Characteristics of individual fitness profiles

Figure 3A illustrates 14 fitness profiles. Description of axes used for interpretation of test achievements are presented in Figure 3B. It shows which variable is plotted in each direction. Distance from the center of the polygon to each vertex represents the value of one test for that profile. The distance from the center to the top of each polygon represents the observed value of each test. The ends of the rays are located at the mean of each variable plus three standard deviations, while the center is at the mean minus three standard deviations.

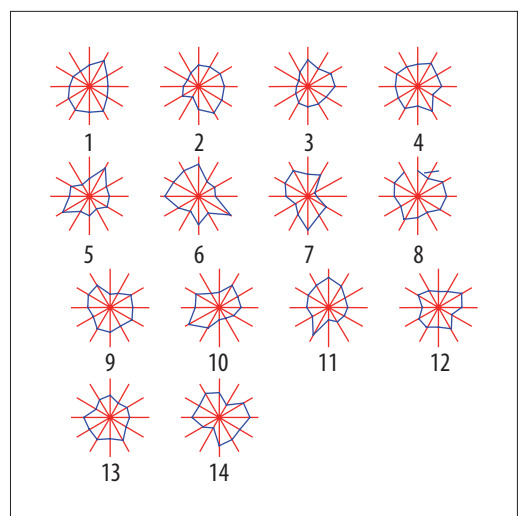


Figure 3A. Individual profiles in special ju-jitsu fitness tests. Each of the little polygons is a glyph and represents one individual profile.

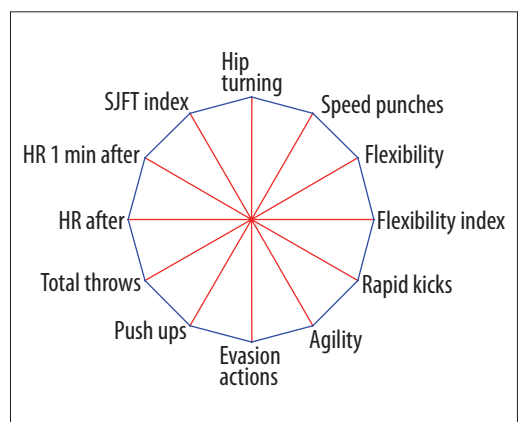


Figure 3B. Key glyph. This plot is used to help interpret Sunray Plots.

Participant No. 9 (aged 40, 27 years of experience, height of 179 cm, weight of 70 kg, 1 dan) was characterized

with shortest time for *Hip turning test* (-1.7 SD). His frequency of punches in *Speed punches test* (-1.1 SD) was also very high. However, his results (as compared to the group) was worse for tests with longer duration in *Rapid kicks test* (0.6 SD), *Evasion actions test* (0.5 SD), *Push-ups* (0.4 SD), number of *Total throws* performed in *SJFT* (-0.5 SD), as well as in *SJFT* index (0.6 SD). The results for remaining tests were at average and maintained within the range of $\bar{X} \pm 0.5$ SD.

Participant No. 14 (aged 20, 8 years of experience height of 164 cm, weight 49 kg, 1 kyu), showed shortest time for *Speed punches test* (-1.4 SD), highest value of *Flexibility index* (1.46 SD) and worse results for *Agility test* (0.6 SD) and *Evasion action test* (1.1 SD), as well as worse scores for *Push-ups test* (-1.7 SD). *Total throws* performed in *SJFT* (-0.5 SD) pointed to lower special endurance, which was proved by the values of HR 1 min after (0.9 SD) and *SJFT* index (1 SD).

No. 10 (aged 26, 12 years of experience, height of 170 cm, weight of 70 kg, 1 dan) presented best results in throws in total (2.4 SD) and lower index in *SJFT* (-1SD). His fitness profile was also characterized by shorter time for *Hip turning speed test* (-1.3 SD), *Rapid kicks test* (-1 SD), *Agility test* (-1.7 SD), *Evasion actions test* (-1.6 SD). The results of other characteristics included in the profile were average ($\bar{X} \pm 0.5$ SD).

From the standpoint of coaching, it can be concluded that the subject No. 9 took advantage in typical speed tests (taking shorter than 15 seconds) whereas worse results could be observed for the test connected with combined endurance and speed. Subject No. 14 also showed mastery in speed-related tests and, additionally, was the best in *Flexibility index*. Subject No. 10, however, was characterized by an advantage in speed endurance tests. His results were the best for this group.

DISCUSSION

The investigations allowed for diagnosis of special fitness preparation among *ju-jitsu* coaches. Relating of the scores obtained among *ju-jitsu* to the standards elaborated in karate and judo standards seems to be disputable [7,8]. With this background, coaches who participated in the *ju-jitsu* coaching course would obtain the following scores, using 1 to 5 points scale:

Hip turning test – Good (4); *Speed punches* – Good (4); *Flexibility index* – Very poor (1); *Rapid kicks* – Good (4); *Agility* – Very poor (1); *Evasion actions* – Regular (3); *Push-ups* – Regular (3); *Total of Throws* – Very poor (1); HR after – Good (4); HR 1 min after – Good (4); *SJFT Index* – Very poor (1).

It is characteristic that no test showed Excellent scores, while the results in four out of eleven results were assessed as Very poor. *Ju-jitsu* coaches demonstrated low special fitness measured with *Flexibility index*, *Agility* and *SJFT*. It is remarkable that they were older than the group of karateists (35.6 vs. 26.8 years) and judoists (35.6 vs. 21.3 years).

In cluster analysis of the results of special *ju-jitsu* fitness tests, some motor competences were distinguished, formed as a connection of the results of the performed tests. Cluster 1 combines movements useful both for defence and attack (*Hip turning* and *Rapid kicks*), Cluster 2 was formed by abilities to perform series of punches and throws and local strength of upper part of the body (*Speed punches*, *Total throws* and *Push-ups*). Cluster 3 encompasses abilities of fast moving forward and backwards along a curved line and kicking range (*Agility*, *Evasion actions* and *Flexibility index*).

Lack of deterioration of fitness tests results with age proves sustained fitness at older *ju-jitsu* coaches. As results from the analysis of individual fitness profiles, older persons can compensate lack of endurance with speed as compared to younger ones whereas special fitness depends exclusively on age. On the basis of individual profiles, one can distinguish between three types of fitness: a) with advantage of speed abilities, performed in short tests up to 15 seconds (using anaerobic lactic substrates), (b) with advantage of speed endurance (anaerobic lactic substrates) and (3) mixed (anaerobic + aerobic). Recent experiment with judokas encompassed measurements of response, where subjects undertook the *SJFT* twice with a ten-minute rest [10], when during the exertion the number of throws was counted and in recovery periods the HR was recorded using the Polar team system (Polar, Finland). Oxygen consumption (VO_2) was measured throughout with the K4b2 (Cosmed, Italia). The blood sample was taken from the earlobe (Dr. Lange lactate – LA analyser). In both repetitions of the effort (trial 1st vs. trial 2nd) similar characteristics were observed. Throws in total (29.2 ± 2 vs. 29.2 ± 2), as well as Index in *SJFT* (10.84 ± 0.8 vs. 10.88 ± 0.7) represents very good level of athletes from National Team. In the series A of *SJFT* were registered, the VO_2 reached 25.9 ± 5.38 vs. 28.9 ± 4.4 $ml \cdot kg^{-1} \cdot min^{-1}$. During first 10-sec break the VO_2 reached 40.5 ± 5.63 vs. 40.2 ± 8.7 $ml \cdot kg^{-1} \cdot min^{-1}$. In series B, the VO_2 was increased to 48.5 ± 4.73 $ml \cdot kg^{-1} \cdot min^{-1}$ vs. 44.9 ± 8.9 $ml \cdot kg^{-1} \cdot min^{-1}$. During the second 10-sec break the VO_2 changes to 50.3 ± 5.0 vs. $49.1.0 \pm 5.3$ $ml \cdot kg^{-1} \cdot min^{-1}$. In series C, the VO_2 increased to 52.8 ± 4.18 vs. 50.0 ± 5.3 $ml \cdot kg^{-1} \cdot min^{-1}$. Those values determined about 80% of VO_{2max} measured in progressive test. Before 1st trial LA was equalled to 1.81 ± 0.32 , but before 2nd trial reached

13.05±2.92 mmol·l⁻¹ and VO₂ consumption fell to approximately 10 ml·kg⁻¹·min⁻¹ [10]. This response shows how body works during intermittent exercise which is typical of fighting and it points to the demand for aerobic endurance. This information can be used by coaches in order to select training measures for development and integration of anaerobic and aerobic endurance with consideration of sport fight demands.

The findings of present work prove that practicing martial art by middle-aged people maintains certain motor, fitness and coordination abilities and skills, useful for self-defence and satisfying human need for security. It is difficult to interpret the findings further without knowledge of the factors of everyday activity in the examined persons. However, it can be assumed that maintaining special motor abilities is necessary for coaching staff for proper *ju-jitsu* coaching since demonstration of techniques and tactics is a fundamental professional activity of each coach in this discipline of sport. Another aspect considered by Douris et al. [11] is the level of general fitness, where middle-aged persons (46.7 years old) showed clear and statistically significant advantage over untrained persons (sedentary group) in balance test, flexibility (sit and reach test), push-ups test (performed in one minute) as well as in sit-ups. Their strength of quadriceps in relation to body weight was higher. No differences were observed for hand-grip test results between martial art group and sedentary group. Aerobic capacity was 41.0 ml·kg⁻¹·min⁻¹ vs. 31.1 ml·kg⁻¹·min⁻¹ for the sedentary group. Moreover, practicing persons were characterized by fat amount lower than in sedentary group [11].

The results of the investigations constitute additional argument for health professionals, who should be aware that there are certain alternative methods to traditional exercise which can increase physical fitness and health of the middle-aged population [11]. In our country, alternative forms of physical education in schools are gaining more attention, which is proved by the author's program

of physical education teaching based on hapkido martial art approved by the Ministry of Education and Sport [12]. Further investigations should be planned with participation of contestant from sport *ju-jitsu*.

CONCLUSIONS

Analysis of the results allows for formulation of the following conclusions:

1. Trained coaches represent different level of motor abilities important in *ju-jitsu*. Integration of special motor abilities in three clusters which form motor competences in coaching staff occurs.
2. Special fitness tests are suitable for control of *ju-jitsu* sport training since they do not require advanced equipment and are easy to be performed. The battery of tests can be used every 4–6 weeks during special preparation period. Due to the specific nature of exercises, last test can be made during period of direct competitive season, 3–4 days before competition.
3. Through special fitness tests, one can check the level of preparation during each stage of training and, repeating these tests, an improvement or regression as a result of the used training load can be observed.
4. Test results can illustrate strength and weaknesses of fitness preparation of the contestants and might provide the framework for modification of training schedules. Furthermore, coaches should also take into consideration medical check-up results and indicators of mental, tactical and technical preparation as well as results of sparring matches and competitions.

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