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The level of special fitness among Brazilian Jiu-Jitsu practitioners, *Gi* formula, takedown zone – analysis of the effectiveness of SJFT flow across disciplines

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Abstract

Background: For combat sports athletes, the best test of technical competence and specialized physical fitness is the body's response to the specific effort required in sports confrontation. The aim of this study was twofold. Firstly, to assess the level of specialized fitness in the context of stand-up fighting among Brazilian Jiu-Jitsu (BJJ) athletes. Secondly, to evaluate the effectiveness of the Special Jiu-Jitsu Fitness Test (SJFT) for the discipline of BJJ. **Methods:** The study involved 22 competitively trained BJJ athletes (age years: 26.66 ± 5.02; Height: 174.25 ± 4.62 cm; Weight: 75.17 ± 7.22 kg; BMI: 24.77 ± 2.44; 6.41 ± 2.65 years of training). Measurements of basic somatic characteristics were performed. Training experience (TE) was diagnosed, and a coaching ranking (CSR) of the participants was developed based on their sports achievements. The participants' specialized fitness was assessed using the Special Judo Fitness Test (SJFT). Test parameters were recorded, and an Index illustrating multidimensional special endurance was calculated according to a specialized formula. Comparative analyses were conducted using statistical procedures to compare selected research results with literature findings from other authors and normative values. Additionally, the relationship between SJFT, TE, and CSR was examined, ultimately evaluating the effectiveness of SJFT in relation to the BJJ discipline. The level of statistical significance was set at $p < 0.05$. **Results:** In the course of the analysis, statistically significant strong negative correlations were found between the sum of heart rate measurements (SHR) and TE and CSR ($R= -0.69, -0.77$; $p<0.001$). The sum of throws (SR) and Indices correlated weakly to moderately with CSR and TE, showing both positive and negative directions. The groups of participants from our study and those from other authors clearly differed in SR and Indices ($p>0.001$, $d= 2.46$ and 2.31), in favor of Judo representatives. To the least significant extent, their heart rate variables (HR max - measurement after the trial; HR 1min. - after 1 minute from the end; SHR - sum of measurements) differentiated them. Results of SJFT variables from our study, positioned within the reference norms of senior Judokas, exhibited a regular level concerning HR max and HR 1min., and a very poor level for SR and Indices. **Conclusions:** The spatial format and the course of physiological mechanisms of the body during the execution of the trial reflect key moments of gaining advantage over the opponent and are consistent with the nature of combat in this discipline. Additionally, the trial promotes performance in field conditions. Based on the obtained results, validation procedures should be conducted in the field of technical and locomotor planes to modify or construct a new specific diagnostic tool for BJJ.

Keywords: combat sports, Brazilian Jiu-Jitsu, throws, special fitness.

Introduction

Specialized fitness represents the synergy of motor skills, physical endurance, and technical abilities specific to a particular sport discipline; in other words, it is the athlete's ability to function effectively within their sports specialization (1,2).

The best assessment of an athlete's technical skills and specialized physical fitness in combat sports will be their response to the specific effort required during competition (3,4). Within the combat sports community, a variety of measurement tools are used to assess specialized fitness, developed for historically and culturally significant Olympic disciplines (5-10). In the environments they create, athletes experience reactions to the specific effort demanded in sports combat (3,4), enabling the monitoring of training adaptations in the area of specialized endurance (specific to the given sport discipline), the level of technical-tactical proficiency, and the speed and quality of its application in combat (11). Special tests should be based on technical elements of the discipline and segments of combat (12).

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The realm of specialized fitness appears to be particularly intriguing and unexplored within the younger, non-Olympic combat sports disciplines such as Brazilian Jiu-Jitsu (BJJ) (13), Ju-Jitsu Newaza (14), or Sport Grappling (15), which have been consistently experiencing dynamic growth in popularity across all continents. Based on scientific premises, it is recommended for these disciplines to utilize specific research tools with a similar specificity of activity (16,17).

BJJ is a hybrid combat sport based on a compilation of traditional Ju-Jitsu, Judo, and Wrestling, among others (18). The confrontation utilizes only grappling techniques (grappling combat sports). The bout can be decided before the time limit (submission, injury, disqualification), by points or advantages (dominance in points or technical advantages), or in the absence thereof, through referee decision (13). The competition involves fighting in two dimensions: standing, using actions rewarded with technical points (maintaining distance and then closing in with throws from Judo, takedowns from wrestling, or specific BJJ guard pulls to bring the fight to the ground), and ground fighting (known as the ground game, utilizing finishing actions such as joint locks, chokes, as well as point-scoring actions like guard passes, sweeps, and advancements to technical positions such as knee-on-belly, mount, and back control) (18).

From the literature available (19) and unpublished athlete-coach observations, it is evident that in BJJ confrontations, the majority of the match occurs in the primary ground dimension, while positional fighting in standing position occurs in a minority and depends on individual preferences, technical-tactical profiles, and opponent actions. It is also known that standing fighting is one of the pillars of the training process for BJJ, aiming to develop technical competencies in sport and broader existential utility [self-defense (20), the ability to control and safely fall (21)]. BJJ in the Gi format (fighting in a judogi, partially similar to Judo) (13), favors the execution of Judo throws. The benefits of using the Special Judo Fitness Test (SJFT) (22) have been described in numerous publications (23-27), and the test has been utilized by many practitioners, in training settings, emphasizing its effectiveness in assessing the specialized preparation of Judo athletes (28).

In seeking a comprehensive diagnosis and assessment of the standing dimension of BJJ and the implementation of specialized fitness tests, it is valuable to consider the knowledge flow and testing attempts from Judo, with a spatial construction utilizing throwing techniques. Such an approach would allow for the evaluation of the suitability of a specific research tool for BJJ and could enable the recognition of the level of specialized endurance as well as the athlete's potential to engage in intense positional combat. Ultimately, this could contribute to optimizing the training process.

The aim of this study was twofold. Firstly, to assess the level of specialized fitness in the standing dimension among BJJ athletes and to examine its variation and relationship with training experience and sports performance. Secondly, to evaluate the effectiveness of the SJFT in relation to the BJJ discipline.

To specify the objectives of the undertaken research, the following research questions were formulated:

1. What is the level and intergroup variation (corresponding comparison) of specialized fitness among observed BJJ athletes?
2. What is the relationship profile between specialized fitness, training experience, and sports performance of the examined BJJ athletes?
3. At what level does the specialized fitness of the examined BJJ athletes rank in comparison to normative values?
4. Is the specific research tool SJFT effective in assessing the specialized fitness of the examined BJJ athletes?

Material and Method

Participants

All participants were informed in detail about the experimental procedure and provided written consent to participate in the experiment. The study was conducted according to the Declaration of Helsinki and approved by the Bioethics Committee at the District Medical Chamber in Krakow (protocol code: No. 226/KBL/OIL/2023).

The study involved a group of 22 men competitively training in BJJ. The group comprised at least two representatives from each of the five senior weight categories in the Gi format (n=3 up to 64kg, n=3 up to 70kg, n=4 up to 76kg, n=10 up to 82.3kg, n=2 up to 88.3kg) according to the regulations of the International Brazilian Jiu-Jitsu Federation – IBJJF (13). The mean body mass of the participants was 75.17 ± 7.22 kg, with a mean height of 174.25 ± 4.62 cm, and BMI of 24.77 ± 2.44. Anthropometer A213 was used to measure height, and the certified electronic scale TANITA TBF-538 was used to assess body mass following anthropometric recommendations (29).

Inclusion criteria for the study included a minimum of 4 years of training experience, absence of injuries, current medical examination, no history of severe injuries, positive medical recommendation, and active participation in competitions. Exclusion criteria included training experience of less

than 4 years, presence of injuries, lack of participation in competitions, history of severe injuries, or negative medical recommendation. The age range of the participants was from 21 to 40 years old (mean age: 26.66 ± 5.02). Training experience ranged from 4 to 14 years of systematic training, with 4 to 6 training sessions per week, depending on the training mesocycle (mean training experience: 6.41 ± 2.65). Belt color ranged from blue to black (N=4 black belts; N=7 brown belts; N=8 purple belts; N=3 blue belts). The research was conducted during the preparatory period. The athletes were not on a restrictive diet. All participants competed in master-class competitions – international, national, and local, and some of them achieved significant sports results, including medals at European and Polish championships, and prestigious grappling tournaments. Information about chronological age, activity, and competition experience was obtained through diagnostic survey method, implemented by direct interview technique among the athletes and coaching staff.

Research Design

The research was conducted according to the following scheme presented in Figure 1.

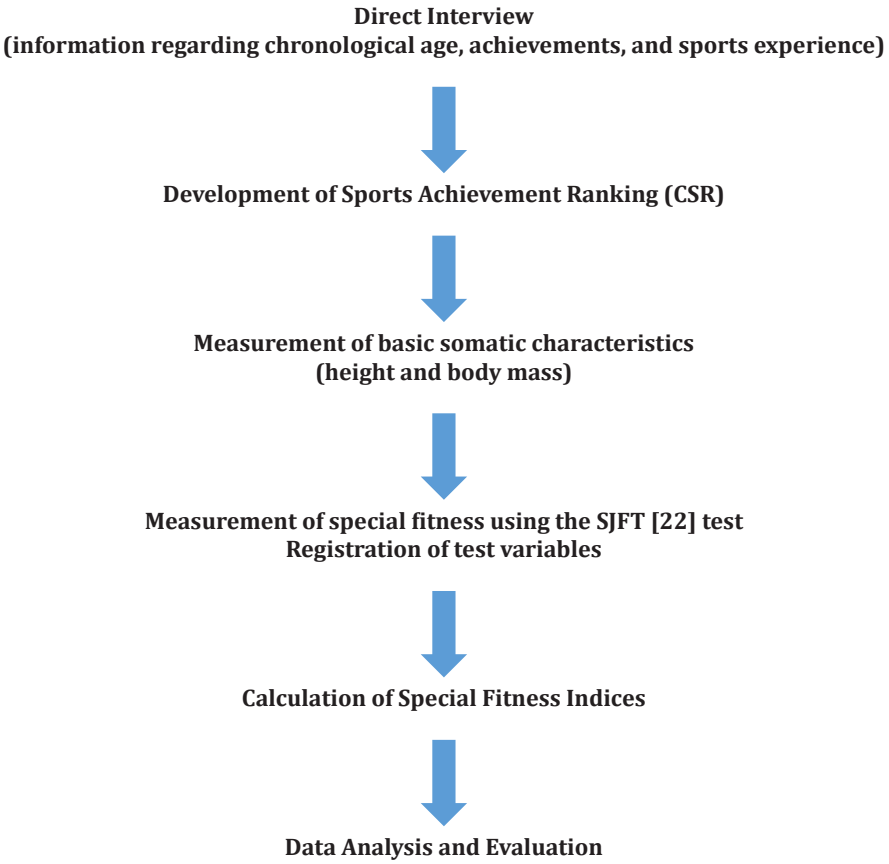

Figure 1. Research Procedure

Research Tools, Testing Procedures

The objectives were pursued using two specialized research tools and a comparative set:

1. Author's ranking of sports achievements (CSR).
2. Special Judo Fitness Test (SJFT) (22)
3. Comparative correspondence comparison

Ranking of Sports Achievements (CSR)

To diagnose the relationships between SJFT results and the sports achievements of the examined athletes (verification of accuracy), a ranking was developed according to guidelines presented in previous studies (30). In essence, the ranking is based on the athletes' achievements throughout their sports career. These achievements were classified according to the point system based on the rank of the sports event throughout their senior career. Information was obtained from athletes and coaches and then confirmed with official communication for individual sports events.

Special Judo Fitness Test (SJFT)

The measurement process was conducted in June 2023, at the Legion Team Tarnów Sports Club. Prior to the measurement procedures, participants were thoroughly briefed on the execution of all stages of the research process.

In a randomized order, participants performed the SJFT on a single training unit, following the protocol proposed by Sterkowicz (22).

1. Preparation of participants for physical exertion..

Before conducting the test, participants underwent a warm-up consisting of 5 minutes of jogging and 10 minutes of general warm-up and stretching exercises (aimed at flexibility and mobility). Subsequently, they performed throws and locomotion movements, which occur in the test, several times at a slow pace to familiarize themselves with the spatial arrangement of the trial, the test tasks, and co-practicing.

2. Material and didactic base.

To conduct the test, testing teams were formed (*tori* and two *ukes* of similar body mass), and the following equipment and tools were prepared: mat (tatami size 2m x 1m x 5 cm, min16 square meters), self-adhesive tape for marking distances on the mat, stopwatch for measuring time, protocol for recording results, and a sport tester (The rate of heart contractions in tests was recorded using a Polar [Finland] 610S sporttester).

3. Execution of the SJFT.

The participants performed a trial consisting of three work periods (15 s - **A**; 30 s - **B**; 30 s - **C**) separated by 10-second passive breaks. Two co-practicing partners (*uke*: 1,2) positioned themselves facing each other in a straight line at a distance of 6m, on spots marked with tape attached to the mat (positions S1, S2). The tested athlete (*tori*) took the starting position (fighting stance, standing) in the middle of the 6-meter distance, facing uke 1 (S0). Upon the command "*Start*," the participant began session **A** by performing the following movement task: moving as quickly as possible in a straight line towards *uke* 1 (S1), using running as the method of locomotion. Sequentially, the participant executed an *IPPON-SEOI-NAGE (I-S-N)* throw on *uke* 1. Then, the participant repeated the same cycle (locomotion, throw) towards *uke* 2 (S2). This sequence was repeated for the entire 15-second work period, as quickly as possible, as many times as possible. The command "*Stop*" signaled the end of the first session and a 10-second passive break. After the break, the second session **B** started from the same starting position. The course of work was the same, with the difference being the duration of work, which was 30 seconds. Successively, after 10 seconds of break, the participants performed the third session **C**, which was identical in procedure. *Tori* executed the throwing techniques with their dominant side. The total time of specialized effective work during the test was 90 seconds (3x30 s), with 20 seconds of passive time (2x10 s breaks between sessions), and the total time was 110 seconds. The aim was to exert intense effort by performing the maximum possible number of *I-S-N* repetitions within the specified time limit. Figure 2 illustrates the global scheme of the test trial, showing the placement and sequence of individual test tasks along with the method and direction of participant movement.

I-S-N is a technique from the group of hand throws, belonging to the family of throws over the back. Officially introduced into the *KŌDŌKAN JŪDŌ* canon in 1997 as a "major technique" (high amplitude of uke's flight phase). *Tori* grips *uke's* sleeve with one hand or two (right/left hand grip on the right/left sleeve at forearm height). Subsequently, *tori* leans *uke* towards themselves, jumps deeply underneath *uke* with a half-turn on bent knees (turning their back to *uke*), while the right/left hand performs what is known as binding *uke's* shoulder (placing the arm under the armpit and then, to close the grip, bending the elbow joint), and finally, the throw is executed by strong arm action (lifting *uke* onto *tori's* back) and straightening the legs. *Tori* performs the throw over the back (31) (Figure 3).

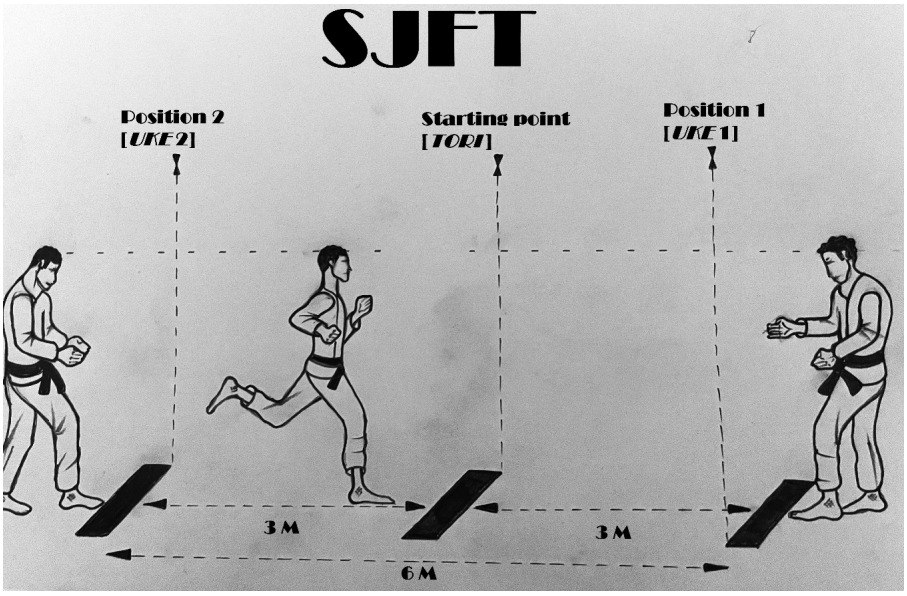

Figure 2. Graphical diagram of the SJFT execution

Source: author own elaboration based on Sterkowicz 1995

Description of the technical *IPPON SEOI NAGE (I-S-N)* used in SJFT:

Figure 3. Graphic diagram of *IPPON-SEOI-NAGE*

Source: Own elaboration

4. Measurement of SJFT Parameters.

In each of the three work sessions, correctly executed techniques were recorded. Subsequently, the heart rate (HR) was measured (beats/min), immediately after the completion of the test (HR max) and after one minute from the completion of the work (HR 1min). Following the formula provided by the test creator (22), based on the relationship: the ratio of the sum of HR measurements after exertion and after 1 minute of rest / divided by the sum of correctly executed techniques from two rounds, the Special Judo Fitness Test (SJFT) performance indices were calculated according to the following formula.

$$\text{Index SJFT} = \frac{HR\,max\,(bpm) + HR\,1\,min.\,(bpm)}{A(l.p.) + B(l.p.) + C(l.p.)}$$

Where:
- HR max - final heart rate, recorded immediately after completing the test
- HR 1min. - heart rate recorded after 1 minute from the end of the test
- A - number of repetitions of throws in the 1st session
- B - number of repetitions of throws in the 2nd session
- C - number of repetitions of throws in the 3rd session

The SJFT index reflects the level of special fitness (in the test) of BJJ professionals, in the standing combat plane, which signifies the effective cooperation of the body's exercise capabilities, overall fitness, and technical skills. The interpretation of the result is inversely proportional; the higher the level of special fitness of the individual tested, the lower the value of the Index.

Correspondence analysis and intergroup differentiation

A selection of 22 literary reports regarding the international study of SJFT (23,24,32-48) in Judo athletes was made. These studies were conducted between 1996 and 2015 and mostly involved non-elite athletes (N=364). The results of other authors were averaged. Finally, the SJFT results of BJJ athletes from our own research were compared and analyzed comparatively with the study of other authors, which included non-elite Judo athletes, the source discipline concerning the SJFT trial.

Furthermore, the results of our own research on BJJ athletes were placed within the standardized normative values for senior Judo athletes (49).

Statistical analysis

In the data analysis, basic statistical methods were applied, calculating the arithmetic mean, standard deviation, minimum and maximum values, lower and upper quartiles, and coefficient of variation. The normality of the distribution was checked and confirmed using the Shapiro-Wilk test. To assess the relationships between the variables, Pearson's linear correlation (r-Pearson) was used. The inference thresholds for correlations were set as follows: r=0.0 to 0.19 indicating a very weak relationship, r=0.20-0.29 indicating a weak relationship, r=0.30-0.49 indicating a moderate relationship, r=0.50-0.79 indicating a strong relationship, and r>0.80 indicating a very strong relationship. The degree of differentiation between selected variable comparisons was assessed using the Student's t-test for dependent variables. Additionally, effect sizes were calculated using Cohen's d coefficient (d=0.20 indicating a small effect, d=0.50 indicating a moderate effect, d=0.80 indicating a strong effect). The analysis of the collected data was conducted using the Statistica software version 13.3 by Statsoft (Statsoft, Kraków, Poland).

Results

Table 1 presents the correlation coefficients of the examined group between SJFT variables and the developed ranking of sports achievements (CSR) and self-reported training experience (TE).

Statistically significant, strong negative correlations were found between the sum of heart rate measurements (SHR) and CSR. The same trend was observed between SHR and TE. For the sum of throws (SR) compared with CSR, a weak (borderline moderate) positive correlation was demonstrated. Conversely, a moderate correlation with the same directional profile was observed between SR and TE. In the case of the multidimensional SJFT Index, negative moderate correlations were found with CSR and TE.

Table 1. Correlation Coefficients between SJFT Parameters and CSR and TE of Investigated BJJ Athletes

Variables	R	p
SJFT (SR) vs CSR	0.29	p>0.05
SJFT (SHR) vs CSR	-0.77	p<0,001
SJFT (Index) vs CSR	-0.41	p>0.05
SJFT (SR) vs TE	0.33	p>0.05
SJFT (SHR) vs TE	-0.69	p<0,001
SJFT (Index) vs TE	-0.44	p>0.05

R-value - correlation coefficient value, p - significance level, SJFT - Special Judo Fitness Test, (SR) - sum of throws in the test, (SHR) - sum of heart rate measurements in the test, (Index) - special fitness index in the test, CSR - ranking of sports achievements, TE - training experience, statistically significant values have been bolded.

Table 2 presents a comparative analysis of statistical characteristics between the results of SJFT for BJJ athletes from our own research and the results of SJFT for non-elite JUDO athletes from 22 international research studies (23,24,32-48).

Based on the analysis of mean values, it can be observed that the compared groups of athletes showed minimal differences in cardiorespiratory variables (HR max, HR 1min., and SHR). The groups of Judokas exhibited more favorable values for these variables. However, it should be noted that these differences were not statistically significant and showed a weak effect. The greatest variation in mean values was observed in the case of SR and special fitness index, favoring JUDO representatives. The groups of combat sports athletes clearly differed in these aspects, as evidenced by the statistical significance of the differences and the strong effect (Table 2).

The coefficients of variation parameters, as shown in the BJJ group from our own research, indicate that the internal variation of the analyzed variables was very low for all SJFT variables (Table 2).

Table 2. Statistical Characteristics of SJFT Parameters from Own Research on BJJ Athletes (n=22) and Non-Elite JUDO Athletes from 22 Studies by Other Authors

Parametr	x̄	sd	min	max	Q1	Q3	CV%	p	d
SJFT (SR) [Own Research]	20.82	1.82	17	24	20	22	9.08	<0.001	2.46
SJFT (SR) [Study by Other Authors]	26.03	2.41	20.20	31	24.85	27.98	9.25		
SJFT (HR max) [Own Research]	183	6.96	173	196	177	187	3.8	0.81	0.07
SJFT (HR max) [Study by Other Authors]	182.54	5.70	172	197	179.40	183.83	3.15		
SJFT (HR 1min.) [Own Research]	155.86	12.11	139	173	143.50	167.75	7.77	0.37	0.27
SJFT (HR 1min.) [Study by Other Authors]	152.71	10.89	136	178	143.75	156.75	7.18		
SJFT (SHR) [Own Research]	338.86	18.58	312	369	320	355.50	5.73	0.49	0.21
SJFT (SHR) [Study by Other Authors]	335.25	15.38	318	375	323.25	340.50	4.63		
SJFT (Index) [Own Research]	16.36	1.35	14.32	20.29	15.59	16.95	8.32	<0.001	2.31
SJFT (Index) [Study by Other Authors]	13.12	1.45	10.80	16	11.78	14.11	11.16		

X̄ - mean, sd - standard deviation, min - minimum value, max - maximum value, Q1 - lower quartile, Q3 - upper quartile, CV% - coefficient of variation, p - significance level of differentiation, d Cohen - effect size of differentiation, SJFT - Special Judo Fitness Test, (SR) - sum of throws, (HR max) - heart rate immediately after the test, (HR 1min.) - heart rate after 1 minute from the end of the test, (SHR) - sum of heart rate measurements; (Index) - special fitness index, statistically significant values and strong effect have been bolded.

Moving on: In the thorough assessment of the special fitness of the surveyed BJJ athletes, it was observed that circulatory variables (HR max, HR 1min.) obtained in the SJFT trial showed a consistent level compared to the reference norms of Judokas (49). However, variables SR and Indexes were at a very weak level (Table 3).

Table 3. Placement of results of BJJ athletes from our own research within the reference norms of senior JUDO athletes

Norms SJFTof Judo athletes					Own research BJJ athletes			
Variables								
Classification	SR	HR max	HR 1 min.	Index	SR	HR max	HR 1 min.	Index
Excelent	≥30	≤166	≤130	≤10.47	-	-	-	-
Good	28–29	167–173	131–141	10.48–11.68	-	-	-	-
Average	24-27	174–188	142–163	11.69–14.22	-	183	155.86	-
Poor	22-23	189–195	164–173	14.23–15.43	-	-	-	-
Very Poor	≤21	≥196	≥174	≥15.44	20.82	-	-	16.36

SJFT - Special Judo Fitness Test SR - sum of throws HR max - heart rate immediately after the test HR 1min. - heart rate after 1 minute of the test Index - special endurance index

Discussion

The aim of this study was to diagnose the level of standing combat proficiency, within the realm of broadly defined special fitness of BJJ practitioners, utilizing the phenomenon of SJFT (22). Additionally, the effectiveness of this specific research tool in assessing the special physical capabilities of the surveyed BJJ athletes was analyzed. It is noteworthy that conducting the specialized SJFT, on one hand, did not require sophisticated equipment, and on the other hand, it could be performed in the training facility.

To effectively employ tests assessing athletes in a given discipline, they must, among other things, be valid. According to sports theory, validity reflects whether a test measures the desired attribute (e.g., technical skill, motor ability, physical capabilities) specific to the discipline (50).

The SJFT allowed for the assessment of cardiovascular fitness and anaerobic endurance of the participants, as indicated by the increased heart rate. The values of cardiovascular stress parameters suggest that the test represented a highly intense effort in the studied group, comparable to sports combat, as the heart rate immediately after completion ranged from 173 to 196 beats per minute (HR max $\tilde{x}$=183±6.96). These results are consistent with literature data indicating that in trained athletes, intense effort based on close combat techniques leads to a minute heart rate increase ranging from 165 to 185 beats per minute (51). Additionally, the HR values from our study are similar to those obtained by a group of athletes after completed matches during the 2005 BJJ World Championships ($\tilde{x}$=182.6 bpm) (52). The physical activity performed by the participants mainly involved anaerobic effort, with energy primarily derived from glycolytic anaerobic processes (50). Anaerobic energy efficiency, power, and muscle strength determine the effectiveness of decisive moments in gaining an advantage over opponents (e.g., scored technical actions: throws, takedowns) (53), which require high energy demand (54). On the other hand, the HR values measured one minute after the test indicate the level of aerobic capacity and post-exercise recovery capacity (22). This is crucial for tournament activity (e.g., in competitive BJJ), where athletes aiming for a medal zone must engage in 4 to 6 matches (55). The analysis of our own research, compared with the results of other authors (23,24,32-48) and normative values (49), revealed a similar level of cardiovascular fitness (HR max, HR 1min.) between BJJ and Judo athletes. This suggests similar requirements in this area for these disciplines. Moreover, significant correlations were demonstrated between SHR and CSR and TE, indicating that cardiovascular adaptation variables are determinants of sports performance, and their higher levels coincide with prolonged training tenure.

In terms of throws, a reduced frequency of movement (number of repetitions) was observed in the third period of work ($\tilde{x}$=7.86±0.71). The throws in the second period were characterized by a higher effectiveness in the number of repetitions ($\tilde{x}$=8.45±0.8). This may be related to the acidification of the body, indicating harmful performance caused by fatigue (50). This also confirms the possibility of assessing anaerobic capabilities among the participants in this test. Upon thorough examination of SJFT concerning BJJ, the values of throws and multidimensional Indexes were analyzed in comparison with non-elite Judo athletes from studies conducted by other authors (23,24,32-48) and reference norms (49). The analysis showed a clear contrast in these aspects in favor of Judo athletes. Participants from our study presented a similar level in this aspect (SR: $\tilde{x}$=20.82; Index: $\tilde{x}$=16.36) only with one group of Judo athletes (SR: $\tilde{x}$=20.2; Index: $\tilde{x}$=15.94) from the study by Da Silva and colleagues (35). Furthermore, the normative location revealed a very weak level for the BJJ participants. This may suggest that specialization based on the specificity of the discipline seems to condition significant disparities in the level of technical task effects in the test. In Judo, standing position fighting (Tachi-waza) takes priority, while ground fighting (Ne-waza) is subject to a series of rules (credibility, continuation of action, and broadly defined progress of actions) that depend on the subjective judgment of the referee and last significantly shorter (56) than in BJJ. Additionally, the

I-S-N technique is one of the most popular and commonly used throws in competitive Judo (31,32). In our own research, based on the analysis of the co-occurrence of SR and Indexes compared with CSR and TE, low and moderate relationships were found, indicating that the effectiveness in executing throws was weakly related to the participants' sporting level, and training experience moderately coexisted with throw efficiency over time. In BJJ, most of the match takes place in the primary ground plane, and positional standing fighting, unlike disciplines such as Judo, Wrestling, is essentially secondary (19). However, this area constitutes one of the pillars of the BJJ training process. It is in the standing position that competitive matches begin. Competitive and coaching experience, along with associated observations, indicate that effectively executed Judo throws or wrestling takedowns are admired and highly valued within the discipline's community. They also provide the athlete with technical points that can contribute to ultimate success. Additionally, a well-executed takedown can limit the opponent's mobility, significantly facilitating the conclusion or control of the match. Effective takedowns are also crucial for athletes preferring the top game style (known as *Guard Passers*) as they allow them to impose their style of play in BJJ matches. From unpublished scientific observation of sports grappling matches (N=29), utilizing the Gi formula (specific to BJJ), it was found that out of 75 attempts to take the opponent down to the ground (37 successful vs. 38 unsuccessful), techniques involving catching the opponent's legs predominated. These techniques included *Morote-Gari* with the capture of 1 or 2 limbs, *Kuchiki-Taoshi, Kibisu-Gaeshi* (N=31; 18 successful vs. 13 unsuccessful), and throws from the *Sutemi-waza group – Masutemi-waza* – such as *Sumi-Gaeshi and Tomoe-Nage* (N=21; 11 successful vs. 10 unsuccessful). Eight guard pulls in BJJ were noted, all of which were continuation attempts following failed S-G or T-N attempts. [In grappling, pulling guard in BJJ results in negative points (15)]. Drawing qualitative conclusions, the *I-S-N* technique could have acted as a certain selective barrier for the participants. Moreover, the method of moving between stations in the test (running) is, according to subjective opinion, a kind of limitation because this form of movement does not occur in BJJ fights. However, individual test protocols for three athletes showed a consistent level in the throws domain ($\tilde{x}$=24). From direct interviews, it emerged that the discussed athletes stated that Judo was their primary discipline (practiced in the past), and their technical-tactical preferences in conducting a match are oriented towards using *I-S-N*.

Flow of SJFT into BJJ

In summary, the specific combination of stimuli used in the SJFT for the BJJ athletes allowed for the measurement of some factors crucial for gaining a significant advantage over opponents in sports matches. Athletes with higher sports achievements and longer training experience showed better levels of anaerobic endurance and cardiovascular fitness (as indicated by HR variables). The spatial format of the test and its tasks allow for simulating conditions present in real sports confrontations. However, there are questions regarding the technical aspect (throws) and locomotion method not present in BJJ matches. When compared to norms and the population of Judokas (23,24,32-49), the participants achieved significantly lower results, showing no significant correlations with CSR and TE. This ultimately resulted in less favorable Special Fitness Indexes. This may suggest that the technical theme (*I-S-N*) and method of locomotion were not suitable for the participants and the BJJ discipline. Therefore, validation actions are recommended for potential modification or new construction of a specific diagnostic tool for BJJ. In coaching practice, these actions can be helpful in selection, monitoring, and planning of individualized training goals. It is also important to exercise caution and consider the broad individualization of the training process with a preference for the technical-tactical conduct of matches by specific athletes (e.g., preferred takedown technique, conducting matches standing or on the ground, fighting from the top or bottom, etc.), where different aspects may have significant importance (30). Individual protocols for three athletes confirmed the validity of the flow of the special test from Judo. Hence, formulating unequivocal conclusions regarding the validity of applying SJFT in the BJJ environment is challenging. Further research in this field is recommended to verify the presented conclusions.

Limitation of Study

At this stage, the sample size can be considered a limitation of the presented study. A limitation of the special test was the repetition of *I-S-N* throws, which may not be preferred by every athlete. In sports competition, athletes often use several different offensive techniques. HR parameters are influenced by climate conditions (temperature, humidity), as well as other factors (stress, overtraining). However, within the unavoidable limitations, the test conditions were well controlled, procedures were conducted according to a strict protocol, and the obtained results are scientifically justified. To capture the multifaceted context of the problem, future research should expand the diagnostics to include a larger number of participants, as well as female athletes. Finally, it is recommended to develop specific tools and individualized experimental training programs that will optimize the level of special fitness for BJJ athletes.

Conclusions

The results of the conducted observations and measurements, their analysis, and evaluation led to the formulation of the following conclusions:

1. The practiced discipline significantly differentiates the level of development of selected aspects of special fitness in combat sports athletes, as measured by the SJFT. A significantly lower level of throw efficiency and Index scores was observed in the BJJ group compared to the Judo group. However, BJJ athletes showed a similar level of heart rate variables compared to Judo athletes.
2. Sporting achievements and training advancement of BJJ athletes in the study were visibly associated with favorable levels of heart rate variables. Conversely, a weak to moderate profile of associations was found when comparing them with throw and Index variables.
3. Comparative analysis of BJJ athletes with normative values for senior Judo athletes showed regular levels for heart rate variables, but very weak levels for throw sum and Index variables.
4. The spatial format and the course of physiological mechanisms during the test reflect key moments in gaining an advantage over the opponent and are consistent with the nature of combat in this discipline. Validation activities are recommended in the technical and locomotion domains to modify or develop a new diagnostic tool specific to BJJ.

Practical Implication

It is recommended to individually utilize the SJFT in BJJ, *Gi* formula, considering the athletes' original discipline and technical preferences. Specifically, regular diagnostics are recommended for athletes who, due to their individual fighting style and technical-tactical profile, prefer *Te-waza - Ippon-Seoi-Naga*, and are focused on increased activity in *Tachi-waza*. The test can be safely administered in training facilities for a comprehensive assessment of fitness and special endurance levels, contributing to the optimization of the training process.

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