

**Research article**

**THE RELATIONSHIP BETWEEN FUNCTIONAL ABILITIES AND  
COMPETITIVE SUCCESS OF SELECTED JUDOKAS**

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**Abstract.** *The aim of this study was to determine the relationship between functional abilities and competitive success on a selected sample of national-level judokas. The study was conducted two weeks before the national championship. The research protocol consisted of the Special Judo Fitness Test (SJFT) and the Multistage Fitness Test (MFT). The SJFT Index was non-significantly higher in non-medalists compared to medalists ( $p = 0.12$ ,  $ES = 0.85$ , moderate). Estimated maximal oxygen consumption ( $VO_{2max}$ ) was significantly higher in medalists than non-medalists ( $p = 0.05$ ). SJFT Index ( $p = 0.04$ ,  $r = 0.48$ , moderate) and  $VO_{2max}$  ( $p = 0.03$ ,  $r = 0.50$ , large) significantly correlated with competitive success in judo athletes. There was no significant correlation between the SJFT Index and  $VO_{2max}$  ( $p = 0.38$ ,  $r = 0.24$ , small). The main findings of this study were: I) medalists performed the SJFT (lower index) better and had a higher  $VO_{2max}$ ; II) SJFT and  $VO_{2max}$  were related to the competitive success of judokas. The results of the study show that significantly higher values of  $VO_{2max}$  and moderately better results on the SPJT (lower values of the SJFT Index) are characteristic of judokas who won medals at national championships than those who failed. The results obtained may be a relatively reliable guideline in the future planning of a specific training process ahead of the most important competition during the competition season.*

**Key words:** judo, fitness test, SJFT,  $VO_{2max}$

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## 1. INTRODUCTION

Judo is a dynamic and physically demanding sport characterized by high-intensity intermittent actions over a short period, five minutes for men's, and four for the women's match (Torres-Luque, Hernández-García, Escobar-Molina, Garatachea, & Nikolaidis, 2016). A large number of different variables (technical, tactical, functional and psychological) determine the competitive result in judo (Dopsaj, Todorov, Vuković, Radovanović, 2013). Over the past decade, several studies have been conducted to determine the demands judokas must meet in order to achieve a top score (Franchini, Del Vecchio, Matsushigue & Artioli, 2011; Pocecco, Faulhaber, Franchini & Burtscher, 2012; Casals, Huertas, Franchini et al., 2017). However, the physiological profile of a judoka and the relationship between aerobic and anaerobic metabolism during the match is still not clear, despite the progression of scientific research in this specific area (Drid, Casals, Mekic, Radjo, Stojanovic & Ostojic, 2015; Prieske, Chaabene, Gäbler, et al., 2020; Kostrzewa, Laskowski, Wilk, Błach, Ignatjeva, & Nitychoruk, 2020). This can be partly attributed to the fact that judokas are divided into weight categories, which creates differences in body mass and body composition, and in individual technical and tactical skills. Both parts of energy capacity, anaerobic and aerobic, are involved during a judo match. Anaerobic capacity enables high-intensity but short-term attacks, while aerobic capacity enables prolonged effort during the potential five-minute duration of the match. During judo matches, very short periods of anaerobic-alactate-based maximum activity with short recovery periods are shifted, during which the level of activity is reduced only to the submaximal in preparation for the next technique (attack). Due to the necessity of performing the desired techniques despite the fatigue created, a high level of physical preparation is required.

The assessment of the physical and functional abilities of judokas over the past two decades has significantly developed from general fitness testing in laboratory conditions to sports-specific testing conducted in the training and competition environment. Judo professionals sought to develop specific tests that would provide as objective assessment as possible of the system and technical and tactical actions used during the match (Azevedo, Drigo, Carvalho, Oliveira, Nunes, Baldissera & Perez, 2007; Franchini, Miarka, Matheus & Del Vecchio, 2011; Almansba, Sterkowicz, Sterkowicz-Przybycień & Comtois, 2012; Pocecco, Gatterer, Ruedl, & Burtscher, 2012; Franchini, Schwartz & Takito, 2020).

The Special Judo Fitness Test (SJFT) is the most commonly used diagnostic test developed with the aim of periodic monitoring of specific judo preparation (Franchini, Vecchio & Sterkowicz, 2009; Agostinho, Junior, Stankovic, Escobar-Molina & Franchini, 2018). Simultaneous assessment of functional preparedness and judo-specific techniques through key elements such as maximum performance, technical execution, fatigue and recovery speed, made the SJFT a generally accepted test. In this regard, SJFT has been used for both diagnosis and evaluation of motor preparation in judokas at different competitive levels. However, limited research has examined the relationships between the SJFT, maximal oxygen consumption ( $VO_{2max}$ ), and competitive success (medalists vs. non-medalists) in judokas. Reporting data relative to competitive success (medalists vs. non-medalists) provides useful insight regarding fitness attributes that are important for judoka selection. The aim of this research was to determine the relationship between functional abilities (SJFT and  $VO_{2max}$ ) and competitive success on the selected sample of national-level judokas (competitors who qualified and competed at a national championship).

## 2. METHODS

### 2.1. Participants

The sample of participants consisted of a total of 22 male judokas competing in categories from 60 kg to 100 kg (mean age  $20.2 \pm 4.3$  years; training experience  $9.8 \pm 1.9$  years). The study was approved by the Institutional Review Board and conducted in accordance with the guidelines of the Declaration of Helsinki.

### 2.2. Procedures

The research was conducted two weeks before the national championship, as the most important competition of the season in the state. The research protocol consisted of the SJFT and the Multistage Fitness Test, which were performed on two different consecutive days, during the beginning part (immediately after the warm-up) of morning training during the final preparations for the national championship. The results of the study were compared to the competitive result achieved at a national championship. Judokas were previously familiarized with both test procedures, had voluntary fluid intake, and a light meal at least two hours prior to testing. The body weight and the fat content of the participants was not measured, considering that rapid weight loss is commonly practiced among judokas in the period of two weeks before the competition (Lakicevic, Roklicer, Bianco, Mani, Paoli, Trivic et al., 2020; Štangar, Štangar, Shtyrba, Cigić, & Benedik, 2022).

### 2.3. The Special Judo Fitness Test (SJFT)

The SJFT is divided into three periods separated by 10s intervals of passive rest (Sterkowicz, 1995; Sterkowicz-Przybycień, Fukuda, & Franchini, 2019). During each period, the judoka was evaluated for sprints and the number of throws each of the two judokas of similar height and body mass made using ippon-seoi-nage (the one-armed shoulder throw), as many times as possible. The judoka began the test 3m from the opponent. The final heart rate (HR) was the value (beats per minute or bpm) recorded immediately after the test; HR 1 min is the heart rate obtained 1 min after the test, and Throws is the number of throws completed during all three periods of the test. The SJFT index is calculated as follows:  $(\text{Final HR} + \text{HR 1min}) / \text{Throws (N)}$ .

### 2.4. The Multistage Fitness Test

The multistage fitness test, 20m shuttle run test or the beep test (Ramsbottom, Brewer & Williams, 1988) is a continuous sub-maximal test that requires the judoka to perform continuous 20m shuttle runs, where the judoka must reach the opposite end of the 20m grid before the next beep sounds. The time between recorded beeps decreases every minute, forcing the judoka to increase their running speed. A protocol began with an initial running speed of 8.5 km/h, with an increase in speed by 0.5 km/h every minute thereafter.

### 2.5. Statistical analysis

Data analyses were performed using IBM SPSS software (version 25.0; IBM Corporation, Armonk, NY). The normality of all data was assessed with the Shapiro-Willk test. A difference in the judo fitness test (index) was determined between medalists and non-medalists using separate independent t-tests, while Mann-Whitney tests were

used to examine differences in  $VO_{2max}$ . The magnitude of the difference between medalists and non-medalists was measured with effect size, Cohen's  $d$  and interpreted (only for normally distributed data) as follows (Hopkins et al., 2009): trivial  $\leq 0.20$ ; small = 0.2-0.59; moderate = 0.60-1.19; large = 1.20-1.99; very large  $\geq 2.0$ . The association between the competing success (medalists and non-medalists) and outcome measures (judo fitness test and  $VO_{2max}$ ) was studied in athletes using the Spearman correlation coefficient and interpreted as follows (Hopkins et al., 2009): trivial (.0-.09), small (.10-.29), moderate (.30-.49), large (.50-.69), very large (.70-.89), almost perfect (.90-.99), and perfect (1.0).

### 3. RESULTS

Mean  $\pm$  SD values for the judo fitness test and  $VO_{2max}$  are presented in Table 1. The SJFT Index was non-significantly higher in non-medalists compared to medalists ( $p = 0.12$ ,  $ES = 0.85$ , moderate). Participation in the study was voluntary, and four judokas decided not to participate in the SFJT protocol due to minor upper body injuries. On the other hand, all 22 judokas completed the multistage fitness test.  $VO_{2max}$  was significantly higher in medalists compared to non-medalists ( $p = 0.05$ ). The SJFT Index ( $p = 0.04$ ,  $r = 0.48$ , moderate) and  $VO_{2max}$  ( $p = 0.03$ ,  $r = 0.50$ , large) significantly correlated with the competitive success of judokas. There was no significant correlation between the SJFT Index and  $VO_{2max}$  ( $p = 0.38$ ,  $r = 0.24$ , small).

**Table 1** Differences between medalists and non-medalists on the judo fitness test and  $VO_{2max}$

Subgroups and outcome measures	mean $\pm$ SD	p values
<i>SJFT Index</i>		
medalists n = 13	11.14 $\pm$ 0.85	0.12
non-medalists n = 5	11.86 $\pm$ 0.83	
<i>VO<sub>2max</sub></i>		
medalists n = 12	41.9 $\pm$ 4.5	0.05
non-medalists n = 10	37.7 $\pm$ 4.9	

SD - standard deviation

### 4 DISCUSSION

The study was conducted with the aim of determining the relationship between functional abilities and competitive results on a selected sample of judokas. The main findings of this study were: I) medalists performed the SJFT (lower index) better and had higher  $VO_{2max}$ ; II) SJFT and  $VO_{2max}$  are related to the competitive success of judokas.

The results obtained showed that all the tested judokas have SJFT Index values that are classified as good, compared to the last published classification criteria (Sterkowicz-Przybycień, Fukuda, & Franchini, 2019). As a lower value of the SJFT Index indicates a better overall result on the Special Judo Fitness Test, the results show that medal winners showed better results but without statistical significance. Since the judokas' anaerobic-alactic system mostly contributes to the technical actions performed in the match, the SJFT can be considered a useful tool for the evaluation of the anaerobic system of judokas due to the efforts performed during the test, and its intermittent nature (Franchini, Sterkowicz, Szmatlan-

Gabrys, Gabrys, & Garnys, 2011). A comparison of judokas in relation to age demonstrates a higher total number of throws (medium effect) and HR immediately after the SJFT (small effect), with limited differences observed for HR one minute after the SJFT (Sterkowicz-Przybycień, Fukuda & Franchini, 2019).

Analysis of  $VO_{2max}$  results showed statistically significant higher values among medal winners than those who did not win a medal. Higher  $VO_{2max}$  values can be important in competitions because judokas allow for faster recovery between consecutive matches on the same day. The Multistage Fitness Test (MFT) has previously been reported to be a valid and reliable test for predicting  $VO_{2max}$  for adults (Ramsbottom, Brewer & Williams, 1988) and has become one of the most widely used field tests, despite the fact that it underestimates  $VO_{2max}$  when compared to laboratory conditions (Cooper, Baker, Tong, Roberts & Hanford, 2005). Although  $VO_{2max}$  is considered relevant to judo performance, existing literature has not shown differences among judokas from different competitive levels (Franchini, Del Vecchio, Matsushigue & Artioli, 2011). Moreover, despite the similarities, the physiological demands of combat or fight practice (randori) are not as high as observed during real competitive matches (Franchini, Brito, Fukuda, & Artioli, 2014).

Our findings on both applied tests on the sample of national-level judokas showed that there is no statistically significant correlation between the SFJT and MFT. The findings suggest that the SJFT and the MFT can be used to some extent to assess judo preparedness ahead of the competition. However, the degree of impact of the judokas' functional abilities on their competitive success during combat remains an unresolved and under-examined issue, which requires further research.

## 5. CONCLUSION

The results of the research show that statistically significantly higher values of  $VO_{2max}$  and moderately better results on the Special Judo Fitness Test (lower values of the SJFT Index) are characterized by judokas who won medals at the national championship in comparison to those who failed. The results obtained may be a relatively reliable guideline in the future planning of a specific training process ahead of the most important competition during the competition season. However, it must not be forgotten that judo is a sport in which technique prevails, and that functional abilities are only the foundation on which judokas base their technique and tactics during the match. Future studies should be designed so that functional testing is associated with accurate match analysis, in an effort to establish an even stronger link between the functional and technical abilities of judokas.

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## POVEZANOST FUNKCIONALNIH SPOSOBNOSTI SA TAKMIČARSKIM USPEHOM DŽUDISTA

*Cilj ovog istraživanja bio je da se utvrdi odnos između funkcionalnih sposobnosti i takmičarskog uspeha na odabranom uzorku džudista nacionalnog nivoa. Istraživanje je sprovedeno dve nedelje pre državnog prvenstva. Protokol istraživanja sastojao se od specijalnog džud ofitnes testa (SJFT) i višestepenog fitnes testa (MFT). SJFT indeks bio je neznačajno viši kod džudista koji nisu osvojili medalje u poređenju sa onima koji su ih osvojili ( $p = 0,12$ ,  $ES = 0,85$ , umereno). Procenjena maksimalna potrošnja kiseonika ( $VO_{2max}$ ) bila je značajno veća kod osvajača medalja nego kod onih koji medalje nisu osvojili ( $p = 0,05$ ). SJFT indeks ( $p = 0,04$ ,  $r = 0,48$ , umeren) i  $VO_{2max}$  ( $p = 0,03$ ,  $r = 0,50$ , veliki) bili su u značajnoj korelaciji sa takmičarskim uspehom džudista. Nije bilo značajne korelacije između SJFT indeksa i  $VO_{2max}$  ( $p = 0,38$ ,  $r = 0,24$ , mali). Glavni nalazi ovog istraživanja bili su: I) osvajači medalja su imali bolji učinak kod SJFT (niži indeks) i imali su veći  $VO_{2max}$ ; II) SJFT i  $VO_{2max}$  bili su povezani sa takmičarskim uspehom džudista. Rezultati istraživanja pokazuju da značajno veće vrednosti  $VO_{2max}$  i umereno bolje rezultate na SJFT (niže vrednosti SJFT indeksa) karakterišu džudiste koji su osvajali medalje na državnom prvenstvu od onih koji to nisu uspeli. Dobijeni rezultati mogu biti relativno pouzdana smernica za buduće planiranje specifičnog dela trenaznog procesa uoči najvažnijeg takmičenja tokom takmičarske sezone.*

Ključne reči: džudo, fitnes test, SJFT,  $VO_{2max}$