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Correlation of anthropometric and bio-motor attributes with Special Judo Fitness Test in senior male judokas

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Abstract
Problem and aim. Most of the preceding studies on SJFT have investigated the performance of various judokas in this test and less attention has been paid to correlation between specific *judo* actions and prominent attributes related to judo athletes' performance. The purpose of this study was to define the correlation between anthropometric and bio-motor attributes, and special judo fitness test.
Methods. Fifty senior judokas (mean ± standard deviation: 20.75 ± 1.80 years old, 178 ± 4.20 cm of height and 21.32 ± 2.81 kg/m^2 of BMI) were assessed for some anthropometric and bio-motor variables, and also specific judo fitness level.
Results. Height was in inverse relationship with SJFT ($P<0.05$). While, the same but a stronger relationship ($P<0.01$) was found regarding sitting height and fat free mass. Moreover, a significant direct correlation was observed between body fat percentage and SJFT. Similarly, lower body strength, vertical jump height and flexibility ($P<0.05$), and hand grip strength and anaerobic power ($P<0.01$) were in inverse relationship with SJFT index. In return, speed ($P<0.01$) and agility ($P<0.05$) were directly related to SJFT index.
Conclusions. It seems that excellent performance in specific judo actions depends largely on muscularity and superiority in anaerobic metabolism because of its correlation with attributes such as fat free mass, strength, speed and anaerobic power.

Introduction

Judo is an Olympic sport which requires top physical, technical, tactical and psychological preparedness [Sterkowicz, Franchini 2001; Katralli, Goudar 2012]. *Judoka* (judo athlete) is engaged in an intense sport event and tries to throw down the rival from behind [Arazi, Heidari 2013]. Judo competition lasts 3 minutes. Commonly, short periods of 20- to 30-second severe activity with 5- to 10-second rest between them occur in a judo event [Van Malderen *et al.* 2006].

In order to efficiently execute specific techniques and tactical skills, a desirable physical fitness is needed. The following parameters have been reported as the important factors in judokas performance; anaerobic power and capacity, strength, and aerobic power [Thomas *et al.* 1989].

Coaches and sport sciences experts always benefit from various physical fitness tests and selection competitions in order to opt national team members and talented athletes at different ages. Most of the tests used, however, are laboratory and some experts believe that they are not so similar to competitive performance of athletes and sport-specific movement patterns [Hesari *et al.* 2014]. Accordingly, specific field tests similar to judo competition such as SJFT have been introduced; the special judo fitness test which was developed by Sterkowicz [Sterkowicz, Franchini 1995] has been investigated by various researches and has also been used to control training procedures and detection of talents in some nations.

Most of the preceding studies on SJFT [Franchini *et al.* 1998; Franchini *et al.* 2005; Franchini *et al.* 2009; Miarka, Del Vecchio, Franchini 2011] have investigated the performance of various judokas in this test and less attention has been paid to correlation between specific judo actions and somatic and functional characteristics. In this regard, Detanico *et al.* [2012] assessed the relationship of aerobic indexes with specific actions in 18 male judokas. They concluded that performance in SJFT was determined by aerobic capacity and power. Szmuchrowski *et al.* [2013] reported no significant relationship between SJFT and WAnT (Wingate Anaerobic Test) results. The

authors suggested that due to research results, WAnT cannot properly evaluate anaerobic capacity of judo athletes. Hesari *et al.* [2014] reported significant inverse relationship between vo2max, peak power and mean power with special Judo fitness test index. They concluded, moderate to strong relationship of physical fitness with SJFT confirmed the validity of SJFT as a valid field test which can properly assess specific judo fitness.

However, neither of limited studies has been targeted to cover the correlation between an almost complete set of required attributes for successful judo contest and performance in SJFT. Preceding studies have commonly investigated the correlation between SJFT with aerobic power and anaerobic capacity which have emphasized on energy systems, and other characteristics related to an excellent performance in SJFT and probably associated with supreme judo fighting seem to be overlooked. Thus, minimal evidence has been revealed regarding whether anthropometric and physical fitness indices are significantly related to SJFT results, and which ones are the most important attributes contributing to privileged performance in SJFT. Hereupon, this study aimed to elucidate the correlation of anthropometric and bio-motor attributes with SJFT results.

Methods

Participants

The sample included 50 senior male judokas (mean ± standard deviation: 20.75 ± 1.80 years old, 178 ± 4.20 cm of height and 21.32 ± 2.81 kg/m^2 of BMI) with at least two years of regular judo training experience and grade of 3 kyu to 3 dan. Participants were informed about test procedures, and written consent forms were then received. This research was approved by the ethic committee on human experiments at the Faculty of Physical Education and Sport Sciences of Guilan University.

Anthropometric assessment

Body weight was measured to the nearest 0.1 kg. Height and sitting height were measured to the nearest 0.1 cm. Body fat percentage was determined using 7 sites measurements of skinfold thickness and with Jackson and Pollock [1978] method.

Bio-motor assessment

A 12-minute run test was used to determine aerobic power. Subjects were instructed to run with possible speed and the distance covered was used to estimate VO_{2max} [Beam, Adams 2013].

$$VO_{2max}\ (ml/kg/min) = (Distance\ (km) - 0.505) \div 0.0447$$

The anaerobic power was evaluated by Running Anaerobic Sprint Test (RAST). Subjects were asked to six 35-meter sprints as fast as possible with 10-second rests between sprints. The time taken for completion of each sprint along with body weight were used to calculate power [Mackenzie 2005].

$$Power = Body\ Weight\ (kg) \times Distance\ (m)^2 \div Time\ (sec)^3$$

Explosive power of lower body was determined by Sargent jump. The difference between starting position with stretched hand and the highest point touched on the graded wall during explosive jump was recorded in cm. The subjects were allowed to 3 tries and the best record was considered.

Maximal strength of upper body, lower body and whole body were assessed via bench press, squat and deadlift tests, respectively. Subjects performed maximal repetitions to failure. 1RM was then calculated using Brzycki equation [Brzycki 1993]. Plus, upper extremity strength was determined through hand-grip test. Furthermore, 45 m sprint, agility 4×9 m and modified sit-and-reach tests were used to determine speed, agility and flexibility, respectively.

Muscular endurance of torso and upper body were evaluated through sit-ups and push-ups tests, respectively. In push-ups, the maximal repetitions were performed to failure. While, sit-ups were completed in 1 minute and number of repetitions was considered.

Special Judo Fitness Test

SJFT is divided into one 15-second and two 30-second periods with 10-second rest intervals between them. The athlete performing test (*tori*) stays between two partners (*uke* A and *uke* B) at a distance of 3 meters from each of them and throws partners via ippon-seoi-nage technique. Both partners should have a virtually same height and weight of the tori has. Heart rate is measured immediately after and one minute after the test. The number of throws and heart rate are placed into related equation and the following index is calculated:

Index = [Final HR (bpm) + HR 1 min. after the test (bpm)] / [sum of throws (in 3 periods) (reps)]

A notable comment of the equation is that the score is inversely related to index. So, the lower index, the better score [Drid, Trivić, Tabakov 2012].

Statistical analyses

After testing normality of data using Kolmogorov-Smirnov, the Pearson correlation coefficient was used

to determine the correlation of anthropometric and bio-motor attributes with SJFT index. Statistical analyses were performed using SPSS 20. Significance level was set at $P<0.05$.

Results

Descriptive statistics of anthropometric and bio-motor attributes, and also their correlation with SJFT results are shown in table 1.

Discussion

The results demonstrate no significant relationship between age and SJFT results. This can be due to taking a specified age range. Height was significantly related to SJFT results ($P<0.05$). The relationship was inverse. This demonstrates the correlation between longer structures and better performance in specific judo tasks. It can be concluded that taller judokas may have more control over the implementation of techniques. A significant inverse relationship ($P<0.01$) was also found between sitting height and specific fitness level in judo. It can be deduced that the longer trunk may facilitate the performance of judo players especially in maintaining balance in struggles, which, in turn, this can be advantageous for them.

There is no significant relationship between BMI and Special Judo Fitness Test. Plus, the association between weight and SJFT results was poor and non-significant. In return, fat free mass was significantly and inversely related to Special Judo Fitness Test. Conversely, the association between body fat percentage and SJFT index was directly significant. According to these findings, it can be concluded that excellent performance in SJFT is more influenced by the ability of force production (which is mainly determined by muscular properties) in comparison to absolute amounts of body mass and also the ratio of body mass to its dimensions. These findings are supported by studies [Callister *et al.* 1990; Little 1991; Thomas *et al.* 1989] which indicated that the judo athletes try to maximize fat free mass along with minimizing fat mass. However, the body fat has been shown to increase linearly from light to heavy weight categories. The mean body fat percentage of judokas was 11.4, which was almost equal to those found in Brazilian team A [Franchini *et al.* 2007].

Judo is characterized by short and high intensity intermittent actions, in which, strength seems to be crucial for strong performance in techniques and groundwork combat [Franchini *et al.* 2008; Franchini, Takito, Bertuzzi 2005]. Little evidence is available regarding judo-

Table 1. Results of anthropometric and bio-motor attributes and correlation with SJFT results.

	Variable	Mean	SD	r	P
Anthropometric	Age, years	20.75	1.8	0.35	0.084
	Height, cm	178	4.2	-0.34	0.016*
	Sitting height, cm	87.2	1.9	-0.387	0.005**
	Weight, kg	70.06	8.24	-0.289	0.42
	BMI, kg/m^2	21.32	2.81	-0.261	0.39
	Body fat percentage, %	11.40	2.26	0.396	0.004**
	Fat free mass, kg	62.7	6.17	-0.582	0.001**
Bio-motor	Upper body strength, kg	78	9.6	-0.249	0.089
	Lower body strength, kg	117	13	-0.312	0.027*
	Whole body strength, kg	130	11	-0.259	0.069
	Hand grip strength, kg	62.18	6.2	-0.385	0.006**
	VO_{2max}, ml/kg/min	54.4	6.4	0.264	0.063
	Anaerobic power, watts	736	5.2	-0.376	0.009**
	Vertical jump, cm	48.58	6.2	-0.341	0.015*
	Flexibility. cm	48	1.8	-0.304	0.032*
	Speed, sec	7.8	1.6	0.366	0.009**
	Agility, sec	8.92	0.9	0.347	0.013*
	Upper body muscular endurance, reps	54.23	0.3	0.783	0.062
	Torso muscular endurance, reps	44.1	2.8	0.712	0.053

** Significance at p≤ 0.05, ** Significance at p≤ 0.01*

kas 1RM in regular exercises such as a bench press and squat. Besides, available data has been found in judokas from diverse levels and different exercises. Interestingly, some researchers demonstrated that the best level in all types of strength are not necessarily required for excellent performance in judo contests, and in some studies, the amounts of dynamic strength among judokas have been shown to be not considerably different compared with general population [Franchini *et al.* 2007; Sbriccoli *et al.* 2007; Heyward, Gibson 2014].

In the present study, a significant adverse relationship ($P<0.05$) was found between lower body strength and SJFT results, while such an association was not observed regarding upper body strength. In this regard, based on Fagerlund and Hakkinen [1991] a significant difference between recreational and international level judokas was found in 1RM squat which was not the case for bench press. However, Franchini *et al.* [2007] reported no significant difference between two groups of judo athletes with virtually same level (national level; team A and reserve members) in bench press, row and squat.

The mean 1RM deadlift was 130 ± 11 kg which was higher than that of Italian Olympic team (127 ± 11) [Sbriccoli *et al.* 2007]. No significant correlation was found between Whole body strength and specific judo fitness. In contrast, hand grip strength was in significant and reverse relationship with SJFT results ($P<0.01$). Judo players require a combination of strength and endurance especially in hand grip strength in order to control proper distance from opponent [Calmet, Miarka, Franchini 2010]. Additionally, such a proper distance is necessary for effective implementation of offensive and even defensive techniques. Thus, the ability to rapidly mobilize a strong grip, and pushing and pulling the rival is an outstanding and distinguishing feature for judokas compared to their rivals and peers [Franchini, Takito, Bertuzzi 2005].

There were significant correlations between vertical jump ($P<0.05$), speed ($P<0.01$) and agility ($P<0.05$) with specific judo fitness, which was reverse for vertical jump and direct for speed and agility. Limited data exists regarding these variables among judo players. In the present study, the mean vertical jump height (48.58 cm) was mainly lower than this reported in preceding studies among senior male judokas (higher than 50 cm) [Farmosi 1980; Claessens *et al.* 1984; Tumilty, Hahn, Telford 1986; Sertić, Segedi, Milanović 2006]. The study which was carried out on the Finnish judokas indicated that international level judo athletes are superior to their recreational counterparts in strength-velocity curve [Fagerlund, Hakkinen 1991]. Given that, the muscle groups which are recruited during judo throwing techniques are those of lower body, furthermore, these techniques are accomplished in a severe manner and against opponent resistance, the differences appear to be an outcome of adaptations [Franchini *et al.* 2011]. These statements comply with the results of the present study and accentuate the importance of strength and power in lower body compared to upper body due to the association with special judo fitness tasks. Since strength is known as a prerequisite for speed and power actions, therefore, in the present study those judokas represented a supreme performance in lower body strength exercise have also showed better records in SJFT.

To be efficiently performed, judo techniques must be accompanied by strength, velocity and power. This requires anaerobic metabolism. Furthermore, the consistency of short-intermittent endeavours and subsequently performance during match, and also faster recovery between matches are supplied by aerobic metabolism [Franchini *et al.* 2009].

An inverse significant association was found between anaerobic power and specific judo fitness. This emphasizes the value of anaerobic metabolism in judo athletes' specific actions. The result was consistent with Hesari *et al.* [2013]. In contrast, no significant relationship was found between aerobic power and SJFT index which was opposite to the findings of the same study. Some evidence demonstrates that the judo athletes who obtain their scores mainly in the last moments of the match show higher magnitudes of VO_{2max} compared to those who gain their scores in the earlier moments [Gariod *et al.* 1995]. Nevertheless, the required energy during maximal exercises which lasts up to 2 minutes has been shown to be derived from both aerobic and anaerobic energy systems. Recently, the time has been taken to reach equal contribution of energy system, however, it has been shown to be less than it was traditionally suggested (approximately 75 seconds) [Gastin 2001]. Collectively, based on the results of the present study, aerobic power seems to be less important than anaerobic power during specific judo actions because of non-significant relationship with SJFT.

There was an inverse significant relationship ($P<0.05$) between flexibility and SJFT index. That is, the higher flexibility was accompanied by better performance in SJFT. Little information exists regarding the flexibility of judo athletes. In this context, Fukuda *et al.* [2013] stated that this martial art contains demanding neuromuscular tasks, suggesting good physical preparation such as flexibility appears to be vital in competitions.

Finally, there was no significant correlation between muscular endurance of upper body and torso and SJFT results. The mean number of repetitions in Push-ups and Sit-ups were lower than that of Canadian (both exercises) and Croatian (just Sit-ups) judo athletes.

Conclusion

According to the findings of the present study, the success of judokas depends largely on certain attributes;

big height and sitting height may help further mastery in performing techniques and balance, respectively. Higher amounts of fat free mass along with lower body fat percentage can be accompanied by efficient force production. Speed and agility, and also dynamic strength and explosive power in lower body may contribute to rapid displacements and to quickly executed throwing techniques. Hand grip strength seems required to adjust the distance from opponent. Techniques can be performed more efficaciously through a wider range of motion which is provided via a favourable flexibility. Ultimately, anaerobic power may be crucial to perform abrupt and explosive arts and also to prevent drop in performance during severe contests.

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Korelacja cech antropometrycznych i bio-motorycznych z testem Special Judo Fitness Test w grupie starszych judoków

Słowa kluczowe: specjalne ćwiczenia judo / moc anaerobowa / muskulatura / szybkość

Abstrakt

Problem i cel. Większość poprzednich badań nad Specjalnym Testem Sprawności w Judo (*po ang*. SJFT) analizowała wyniki różnych judoków biorących udział w tym teście, mniej uwagi poświęcając korelacji pomiędzy konkretnymi działaniami judo a znaczącymi cechami związanymi z wynikami judoków. Celem niniejszego badania było określenie korelacji między cechami antropometrycznymi a bio-motorycznymi oraz specjalnym testem sprawności w judo.

Metody. Oceniano grupę pięćdziesięciu judoków seniorów (średnia ± odchylenie standardowe: 20,75 ± 1,80 lat, 178 ± 4,20 cm wzrostu 21,32 ± 2,81 kg/m2 BMI) na podstawie niektórych zmiennych antropometrycznych i bio-motorycznych, a także określonego poziomu sprawności w judo.

Wyniki. Wzrost był odwrotnie proporcjonalny do SJFT (P <0,05). Stwierdzono takie same, ale silniejsze relacje (P <0,01) dotyczące wysokości siedzenia i masy mięśniowej wolnej od tłuszczu. Ponadto zaobserwowano znaczną bezpośrednią korelację między procentem tkanki tłuszczowej a SJFT. Podobnie, niższa wytrzymałość ciała, pionowa wysokość skoku i elastyczność (P <0,05), siła chwytu ręki i moc anaerobowa (P <0,01) były odwrotnie proporcjonalne do indeksu SJFT. Z kolei prędkość (P <0,01) i sprawność (P <0,05) były bezpośrednio związane z indeksem SJFT.

Wnioski. Wydaje się, że doskonałe wyniki w konkretnych działaniach judo zależą w dużej mierze od umięśnienia i przewagi w metabolizmie beztlenowym ze względu na jego korelację z takimi cechami jak: wolna od tłuszczu masa mięśniowa, siła, szybkość i moc anaerobowa.