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Body composition, strength and specific physical fitness as factors to discriminate performance in judokas

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Abstract

Background & Study Aim: Body composition, maximum strength and the special judo fitness are determining factors to high-level judo performance. The aim of the present study was to relationships between indicators of body composition, maximum strength and special judo fitness can discriminate between judokas of different competitive levels who have yet to reach international status.

Material & Methods: A total of 19 judokas, aged 24.3 ±5.3 years were divided into two groups, according to the titles or classification won in the previous 3 years in regional (RE) or state and national (SN) competitions. Body composition, the 1-RM test of squat, supine and a barbell row (B-Row), and the Special Judo Fitness Test index (SJFT-I) were applied to both groups.

Results: Body fat (BF), fat-free mass (FFM), lean body mass (LBM) and body fat percentage (BFP) were not determining factors to indicate judokas level. However, 1-RM of the squat and B-Row test identified athletes with the best competitive performance. The SN group obtained the best SJFT index (SJFT-I).

Conclusions: The 1-RM test with squat and row exercises, as well as the SJFT-I were able to identify judokas with the best competitive performance. Although BF and body composition can vary between weight categories, it is not a good indicator to differentiate regional judokas from their state and national counterparts.

Keywords: 1-RM • combat sports • competitive levels • maximal strength • performance • Special Judo Fitness Test

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INTRODUCTION

Special Judo Fitness Test – test used to diagnose specific physical fitness in judo, structurally very similar to the structure of judo actions.

Competitive levels – they are different levels of performance and sports achievements.

Combat sports – *noun* a sport in which one person fights another, e.g. wrestling, boxing and the martial arts [48].

Maximal strength – the maximum strength that can be developed in a given movement.

Body composition – the proportion of lean mass and fat mass in the athletes body.

Strength training – *noun* training that aims to build muscle strength, usually resistance training [48].

Performance – *noun* the level at which a player or athlete is carrying out their activity, either in relation to others or in relation to personal goals or standards [48].

1RM – individual's maximal strength or 1 repetition maximum [49].

Dan (dan'i) – a term used to denote one's technical level or grade. In *j*ūdō, the "***dan***" ranks start at shodan (1- ***dan***) and go up to the highest grade of *j*ūdan (10- ***dan***) [50].

Combat sports, such as judo, are highly complex due to the characteristics of the fight and the need for physical, technical and tactical training. The movements of judokas in competition are unpredictable and depend on the movements, actions and reactions of their opponents. Variables such as style, technique, tactics and experience are determining factors in judo training [1-3].

Most fighting time in a judo match involves gripping, which require high levels of isometric and dynamic strength, with explosive movements of both lower and upper limbs and an effort: pause ratio of 2:1 or 3:1 [1, 3]. Although aerobic fitness is also important in the last minutes of a bout, for the golden score and between-match recovery, it is not well developed in judokas [4]. Among the physiological demands of judo, there is consensus that the glycolytic pathway is essential [4, 5-7] although judokas need strength to execute strikes or throws [8].

Some authors consider maximum, explosive and endurance strength, as the most important physical abilities for judokas [5, 7, 9, 10]. Strength training is part of the training routine of judo athletes [11] and specific machines have been developed for that purpose [8], demonstrating the importance attributed to this physical ability. Judo is divided into weight categories, and body composition is a variable that should be monitored during the entire training process. High-performance judokas have low levels of body fat, except those in the heavyweight category [1].

Specific assessment has also been a concern in judo. Proposed by Sterkowicz [12], the Special Judo Fitness Test (SJFT) is specific for judo and has been widely used because its physiological demands are similar to those required in competition [13-16].

With respect to high-level judo performance, a number of studies have demonstrated that certain performance factors can differentiate between high-level athletes and their lower-level counterparts. Callister et al. [17] found that high-ranking American judokas have a lower fat percentage than that of intermediate-ranked individuals. Body composition can affect the anaerobic and aerobic performance of judo athletes [18], distinguish junior from senior categories [19] and recreational individuals from professionals [20]. As such, athletes try to decrease their body fat percentage and increase lean mass to obtain advantages, in order to remain within the limits of their respective categories [21, 22].

Strength is also considered vital for judo performance [23-26], and the 1-RM maximum test is used to assess athletes in different exercises, including supine, squat and row [15, 27]. These movements involve important motor actions performed in combat, such as pushing, pulling and squatting. The SJFT can distinguish between judokas from different competitive levels [28, 29] and can be used to classify the specific physical fitness of these athletes [30].

The variables that differentiate competitive performance in judo require more information, primarily when regional, state and national athletes with international aspirations are compared.

The aim of the present study was to relationships between indicators of body composition, maximum strength and special judo fitness can discriminate between judokas of different competitive levels who have yet to reach international status.

Our hypothesis is that these three dependent variables can distinguish judokas from national and state levels.

MATERIAL AND METHODS

Participants

A total of 19 male judokas, aged 24.3 ±5.3 years, and 1st dan black belt holders, participated in the study. The judokas were divided into two groups, according to their main titles, obtained in the three previous years at regional or state/national competitions. The state/national group (SN) consisted of 10 judo athletes who had won medals at state or national championships. The other group was composed of 9 judokas who had won medals in regional competitions (RE). Group composition in terms of weight categories is exhibited in Table 1.

Assessments were conducted at the local of the judokas training. All the subjects were instructed not to train for at least 24 hours before the tests, or change their sleep routine, eating and water drinking habits and not to consume alcoholic beverages.

Table 1. Group composition by weight categories: state/national (SN) and regional competitions groups (RE).

Weight categories	SN (n = 10)	RE (n = 9)
< 60 kg	1	1
60-66 kg	2	1
66-73 kg	2	1
73-81 kg	1	2
81-90 kg	2	1
90-100kg	1	2
>100kg	1	1

After the procedures were explained, all the participants gave their informed consent to take part in the study, which had been previously approved by the local Ethics Committee (CAAE: 53686516.7.0000.5398).

Body Composition

Body weight was measured with a scale accurate to 0.1 kg and maximum capacity of 150 kg (Filizola, SP, Brazil), with subjects standing at the center of the scale barefoot, wearing only shorts. Height (cm) was measured by a wall-mounted stadiometer, accurate to 0.1 cm. Skinfolds (tricipital, subscapular, suprailiac, abdominal, mid-axillary, mid-femoral and pectoral) were measured using a Scientific Plicometer (Cescorf, Porto Alegre, Brazil), accurate to 0.01 mm, with the Jackson and Pollock protocol as reference [31].

Body density was obtained by the following equation BD (Body Density) = 1.11200000 – m[0.00043499 (ST) + 0.00000055 (ST)^2] – [0.0002882 (age)], and fat percentage (FP) using the equation: [(4.95/BD) – 4.50] x100 [31]. Next, we calculated fat-free mass (FFM), lean body mass (LBM = absolute lean mass · height^2) and body fat percentage (BFP = absolute body fat · height^2).

Maximum Strength (1-RM)

The subjects underwent one repetition maximum (1-RM) testing [32]. The following exercises were performed: supine, squat and barbell row (B-Row). These exercises were selected due to their biomechanical similarity with some judo movements (pushing, pulling and squatting). Given that different weight categories were being tested, it was established that the force index would be calculated by the absolute weight percentage of the test in relation to the body weight of the athlete.

Specific assessment

For specific assessment, the SJFT, as proposed by Sterkowicz [12], was applied. The SJFT index (SJFT-I) was expressed as arbitrary units (au), in line with the equation below. The lower SI represents the better performance on the test. SJFT-I = (Final HR (bpm) + HR after 1 minute (bpm) / number of strikes applied). Where HR = heart rate; bpm = beats per minute.

Data analysis

Data normality was confirmed by the Kolmogorov-Smirnov test. Next, descriptive analysis was carried out to characterize the sample, followed by the student`s t-test for independent samples to compare the two groups in terms of strength tests, body composition and specific assessment. All the analyses were conducted using SPSS statistical software (SPSS Inc. Chicago. IL), version 17.0, and the significance level was established at 5%.

RESULTS

Sample characterization is presented in Table 2. There was no significant difference between the indicators assessed. Both groups contained representatives of all weight categories: from lightweight (<60 kg) to heavyweight (>100 kg). This explains the large standard deviation in the weight of the subjects. It was found that BF, FFM, LBM and BFP were not determining factors to indicate judokas level.

Table 3 presents the results of 1-RM and SJFT tests. Despite the higher absolute values in the SN group on the 1-RM test, they were not significantly different. However, the relative values on the squat and B-Row test identified the athletes

Table 2. Participant characterization: state/national (SN) and regional competitions groups (RE).

Variable	SN (n=10)	RE (n=9)	Difference	p-value
Age (years)	24.8 ±5.1	23.9 ±5.2	0.9	0.708
Weight (kg)	86.8 ±20.3	87.4 ±22.5	0.6	0.952
Fat mass (kg)	14 ±3.4	16.7±11.2	2.7	0.476
Free fat mass (kg)	72.8 ±12.8	70.8 ±12.1	2	0.731
BF (%)	16.2 ±3.1	17.4 ±8.2	1.2	0.667
LBM (kg · m^2)	21.7 ±2.4	21.8 ±2.3	0.1	0.433
BFP (kg · m^2)	3.8 ±1.0	4.7 ±3.2	0.9	0.943

with the best competitive performance. The SN group also obtained the best SJFT results, with lower indices.

DISCUSSION

Our hypothesis was confirmed, except in relation to body composition. Body composition, assessed by BF, FFM, LBM, BFP did not discriminate between judokas levels. On the other hand, the 1-RM test involving B-Row and squatting differentiated judo athletes with better performance, when the load was normalized to body weight. The same occurred with the SJFT index, since higher level judokas obtained the lowest SJFT index.

The body composition result of the present study corroborates a number of recent studies. Other investigations with Brazilian judokas also found no differences in body composition between medalists and non-medalists in the Brazilian Senior Judo Championship [33], National A, B and C teams [15], or Croatian judokas with better or worse performance [34]. Moreover, no difference in fat-free mass was found between Olympic athletes and participants in Asiatic games compared to university students [20].

Given that judo is divided into weight categories, body composition is expected to be an important performance parameter. Indeed, judokas of world and Olympic level have an estimated 4 to 9% body fat [4]. Heavyweights (>100 kg) are the exception, often exhibiting a higher fat percentage than that of judokas from other categories [35], since there is a lower (> 100 kg) but no upper weight limit for this category. However, based on our results and earlier studies, body composition was not a determining factor for judo performance. These findings may be related to the low average BF of judokas in the aforementioned studies by Silva and Santos [33] - 9.2% and Franchini et al. [15] 10.1%. Our results obtained higher values (BF = 16.2 and 17.4%); however, data analysis without judokas from the two heaviest weight categories (90-100kg and >100kg) showed that the mean BF of the groups fell to 13.8% (SN) and 14.4% (RE). Joint data analysis

Table 3. 1-RM and SJFT test results of State/national (SN) and regional competitions groups (RE).

Variable	Evaluation criteria	SN	RE	Difference	p-value
Supine	absolute (kg)	125.6 ±23.9	117.6 ±30.9	8	0.533
	relative (%)	44.3 ±12.6	29.1 ±21.4	15.2	0.073
Squat	absolute (kg)	141.3 ±30.7	126.2 ±30.3	15.1	0.296
	relative (%)	62.9 ±17.4*	41.5 ±23.4	21.4*	0.035
B-Row	absolute (kg)	110.9 ±23.4	103.3 ±23.6	7.6	0.490
	relative (%)	25.7 ±7.7*	13.8 ±14.3	11.9*	0.033
SJFT-I	(ua)	11.9 ±0.5*	13.1 ±0.8	1.2*	0.0006

*p<0.05. Absolute weight values on the 1-RM test in relation to body weight. SJFT-I = SJFT index; B-Row = barbell row

resulted in the heavier weight categories increasing mean BF in our sample. In studies that found body composition of high-performance judokas comparable to that of the present study, the results ranged from 13.9% to 15.7% [18]. Analysis of BF in judokas must consider weight category. The small number of individuals per weight category is a limitation of this study.

In 1-RM assessment, the SN group performed better in the B-Row and squat exercise when the load was normalized to body weight. These two exercises are similar to two very important judo actions: pulling, in preparation for the strike, which serves to destabilize the opponent, and squatting, used in several strikes, primarily those requiring the hip and legs. Leg strength to project the opponent and arm and torso strength to immobilize, escape, pull and dominate the adversary are very important for judokas [8], which may explain the difference in strength between the two groups. Although the groups did not differ in body composition, the group with the best performance displayed the highest relative strength. Corroborating our results, other studies found strength differences between elite and non-elite judo athletes. Barbado et al. [39] reported greater torso extension strength in international-level Spanish athletes when compared to their national counterparts. Drid et al. [27] found differences in 1-RM tests for supine and deadlift exercises between international and national European judokas. However, in the same study, no intergroup difference was found for the 1-RM squat test. Likewise, Fagerlund and Hakkinen [41] compared elite and recreational Finnish judo athletes in the 1-RM test, finding a difference in the squat but not the supine exercise. By contrast, Franchini et al. [15] not found difference in dynamic force between team A, B and C members of the Brazilian national squad, for 1-RM tests involving supine and squat and row exercises, in both absolute and relative terms. In this case, despite the different classification of teams A, B and C, all the athletes participated in international competitions and possibly exhibit similar competitive levels, which may explain the absence of a difference between the groups of that study.

Although the maximum strength test results are conflicting, strength and its manifestations are essential physical abilities for a judoka. They are considered determining factors for competitive success [25, 42] and can be improved within a short time frame [43]. Amtmann and Cotton [9] report that strength training is essential for judo, in order to improve competitively and prevent injury, which in itself is important for the athlete to remain healthy and achieve high performance. Furthermore, periodized strength training may enhance specific judo moves, such as the number of SJFT throws [44], arm and leg strength [43] and strength in specific judo maneuvers, as demonstrated by Blais and Trilles [8], who used a machine adapted for judo. As such, strength training, in conjunction with technique and tactics, should be part of planning strategy [45].

In the present study the SJFT index distinguished regional judokas (RE) from those at the state and national (SN) level, as well as medalists from non-medalists, in high-level competitions [28, 29]. According to Franchini et al. [30], the SJFT index achieved by athletes in this study can be classified as good for the SN group (11.9) and fair for the RE group (13.1). Athletes with a international performance level exhibit index below 11.7. This is further evidence that the test is an excellent instrument to assess the evolution of specific physical fitness. Detanico and Dos Santos [37] report that the SJFT has been used by the leading international judo teams to diagnose athletes training status and help in training structure and periodization. Likewise athletes with best SJFT index showed higher effectiveness during the judo matches [46]. The structure of the test, with intermittent high- intensity exertion and elevated energy demand from the glycolytic system, simulates the characteristics of a judo combat [4, 14, 16, 47]. Thus, due to its high energy demand, and ability to differentiate and classify, the SJFT is an instrument that should be used to assess competitive judo teams, even for athletes still striving to reach high-competitive levels.

Despite the evidence presented in this study regarding the importance of maximum strength in the 1-RM test and the SJFT index, the small number of subjects per weight category is a limitation. Comparing a larger number of judokas in the same weight category may provide additional information on body composition, strength and specific assessment. In any event, our results demonstrate that the SJFT index and the 1-RM test are good indicators to distinguish SN judokas levels from their RE counterparts.

CONCLUSIONS

The 1-RM test using B-Row and squat exercises, as well as the SJFT-I were able to identify judokas with better competitive performance. The 1 RM and SJFT tests are good indicators to discriminate between different competitive levels. Although BF and body composition can vary between weight categories, it is not a good indicator to differentiate regional judokas from their state and national counterparts. Further studies with a larger number of participants per weight category should be conducted to better clarify the extent to which the variables studied can distinguish between judo athletes of a same category.

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