

ANTHROPOLOGY

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Anthropometric Profile, Wingate Performance and Special Judo Fitness Levels of Turkish Olympic Judo Athletes

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Abstract

Background. Judo is an Olympic sport where physical fitness is of great importance as well as technique and tactics. Physical and physiological conditions of the athletes are very important for a better judo performance and there is still a need for more data related to these determinants.

Problem and aim. There is a need for more data concerning anthropological determinants of judo athletes. Thus, the aim of this study was to evaluate anthropometric profile, Wingate and Special Judo Fitness Test (SJFT) performance.

Methods. The following tests and measurements were conducted in order to investigate anthropometric profile, Wingate and Special Judo Fitness Test (SJFT) performance of male (n=7) and female (n=10) judo athletes from Turkish Olympic judo team: anthropometric measurements, Wingate anaerobic test (WanT) and SJFT. An independent Student t test was used to compare male and female athletes. Pearson product correlation was used to verify the relationship between variables. Effect sizes were calculated following the recommendations by Rhea (2004).

Results. There were differences between male and female athletes in the following variables; fat-free mass, body fat percentage, peak and mean power, HR after the set A and in the SJFT index ($p<0.05$). Large and very large correlations were found between anthropometric measurements, SJFT parameters and WanT performance results ($p<0.01$). Large correlation was found between fat-free mass and HR values during SJFT sets ($p<0.05$).

Conclusions. It can be concluded that the higher the fat percentage, the lower is the performance in activities involving body displacement. In conclusion, sex and weight differences should be taken into consideration while evaluating judo athletes and because higher fat-free mass means better SJFT performance, the training program should be organized to decrease or maintain body fat and increase muscle mass.

Introduction

Judo is a grappling combat sport that was introduced in the Olympic Games in Tokyo 1964 [Boguszewski 2006]. To be successful in judo competitions, athletes should present well-developed technique, tactics and physical fitness [Franchini *et al.* 2011]. As a part of evaluating the overall fitness levels of the athletes and setting guidelines for individualized training program, physiological testing is commonly used [Detanico, Santos 2012]. Some physical fitness and anthropometrical variables are considered requisites for high-performance in judo competition [Franchini *et al.* 2011]. As judo is a weight-classified

sport, it has been suggested that high-level judo players should have low body fat [Kubo *et al.* 2006; Franchini *et al.* 2011; Kim *et al.* 2011]. Callister *et al.* [1991] reported that body fat percentage of high-level judo athletes were lower than those worse qualified in the USA ranking. Franchini *et al.* [2007] observed that body fat percentage was negatively related to number of throws during the Special Judo Fitness Test, while Kim *et al.* [2011] reported that fat-free mass was positively correlated to anaerobic performance in judo athletes. Many judo-specific tests have been developed to evaluate performance of the judo athletes and it was claimed that these tests could reflect the variables relevant to official match per-

formance [Almansba et al. 2011; Detanico, Santos 2012; Franchini et al. 2005a; Franchini et al. 2005b; Franchini et al. 2011]. The Wingate is the most non-specific test used to evaluate the anaerobic performance of judo athletes, while the Special Judo Fitness Test is the judo-specific test most frequently used to assess mixed anaerobic and aerobic performance in judo athletes [Franchini et al. 2011]. In fact, Special Judo Fitness Test classificatory tables were elaborated to evaluate male [Franchini et al. 2009] and female judo athletes [Sterkowicz-Przybycien, Fukuda 2014].

Despite the relevance of anthropometrical and physiological variables to judo performance, the only database indexed article comparing the physiological and anthropometrical profiles of Olympic-level male and female judo athletes was published more than a decade ago [Sbriccoli et al. 2007]. These authors reported higher Wingate peak and mean power in male compared to female judo athletes. Other aspects such as endurance capacity have been investigated in male and female judo athletes [Sterkowicz-Przybycien, Fukuda 2016], but the comparison between sexes, especially among high-level athletes, is considered relevant to improve the training organization for both male and females. Thus, the aim of this study was to determine and interpret physical and physiological profiles and SJFT performances of Turkish male and female judo athletes.

Method

Participants and procedures

Ten female and 7 male judo athletes who were part of the Turkish Senior Olympic Judo Team voluntarily participated in this study. After informing the athletes about the procedures, which they were already familiarized to, anthropometric measurement was carried out. On the next day, WanT was used to determine peak, mean power and fatigue indexes and after 48 hours the SJFT was conducted.

Tests and Measurements

Anthropometric Measurements: After body mass and height measurements, body fat percentage, fat-free mass and fat mass were measured with BC-558 IRONMAN® Segmental Body Composition Monitor (TANITA). Body mass index (BMI) was calculated from height and body mass using Quetelet's equation:

$$\text{BMI} = \text{body mass (in kg)} / \text{height}^2 \text{ (in m)}$$

Wingate Test: Lower-body 30sWAnT was used (Bar-Or 1987). The examined competitors performed the test using the “Monark 824 Ergometric”, with 7.5% load

related to their body mass. Athletes maintained an all-out effort throughout the test and were verbally encouraged by the same person.

Special Judo Fitness Test: This test has the following time structure: 15 s (A), 30 s (B), 30 s (C) with 10 s intervals. During each period, the executor threw two partners (6 meters apart from each other) as many as possible with *ippon-seoi-nage* technique. The athlete's HR was recorded immediately after the test and 1 min later. Based on the number of throws and heart rate (HR) values, an index was calculated according to the following equation [Franchini et al. 2009; Sterkowicz 1995]:

HR_{end} : heart rate immediately after the test

$\text{HR}_{1\text{min}}$: heart rate 1 minute after the test

Throws: number of throws completed in the test

Additionally, HR measurements were conducted during the whole test and values for each set were also registered.

Statistics: Data are presented as mean and standard deviation. An independent Student t test was used to compare male and female athletes. Pearson product correlation was used to verify the relationship between variables. Correlation coefficients were classified according to Hopkins (2018). Effect sizes were calculated following the recommendations by Rhea (2004). Thresholds values to effect size were <0.25 (trivial), 0.25 to 0.50 (small), 0.50 to 1.0 (moderate) and >1.0 (large).

Results

Table 1 presents the anthropometric characteristics of both groups.

Concerning anthropometrical characteristics female judo athletes were shorter, presented lower fat-free mass, and higher body fat percentage than males, all with moderate effect sizes. No other significant difference was found, and trivial or small effect sizes were observed.

Table 2 presents the performance in the WanT.

Peak and mean power were higher for males compared to females, with moderate effect sizes, but no difference was found for the fatigue index and trivial effect size.

Table 3 presents the performance and physiological response to the Special Judo Fitness Test.

The only differences observed between male and female judo athletes were a higher HR after the set A (with small effect size) and a higher SJFT index – with moderate effect size – for females compared to males. No other significant difference was found, with trivial or small effect sizes.

The correlations between Wingate and SJFT variables were large and very large, while anthropometrical variables were large and very large correlated to Win-

Table 1. Anthropometrical characteristics of female and male judo athletes (values are mean and standard deviation)

Variable	Females (n = 10)	Males (n = 7)	t	p	d
Age	24±2.1	26±2.3	-	-	-
Height (cm)	161.9 ± 7.1	172.0 ± 9.8	-2.50	0.025	0.60
Body mass (kg)	67.6 ± 19.8	88.1 ± 22.8	-1.97	0.066	0.48
BMI (kg/m ²)	25.4 ± 5.7	29.4 ± 5.8	-1,42	0.175	0.34
Body fat (%)	21.6 ± 5.8	13.6 ± 4.4	3.08	0.007	-0.78
Fat mass (kg)	15.5±8.9	12.8±7.2	0.66	0.515	0.16
Fat-free mass (kg)	52.1±11.1	75.3±15.7	-3.58	0.002	0.86

BMI= Body mass index

Table 2. Wingate test performance for female and male judo athletes (values are mean and standard deviation)

Variable	Females (n = 10)	Males (n = 7)	t	p	d
Peak power (W/kg)	9.88±1.31	12.06±2.13	-2.61	0.019	0.63
Mean power (W/kg)	6.65±1.26	8.16±0.99	-2.64	0.018	0.67
Fatigue index (%)	54.57±12.66	58.91±7.32	-0.81	0.428	0.21

Table 3. Special Judo Fitness Test performance and heart rate responses for female and male judo athletes (values are mean and standard deviation).

Variable	Females (n = 10)	Males (n = 7)	t	p	d
Throws in A (rep)	6±0	6±1	-1.95	0.069	0.47
Throws in B (rep)	10±1	11±1	-1.37	0.190	0.33
Throws in C (rep)	9±1	10±1	-1.60	0.128	0.39
Total throws (rep)	25±2	27±3	-1.74	0.101	0.42
Heart rate A set (bpm)	165±6	151±17	2.39	0.029	-0.59
Heart rate B set (bpm)	184±5	178±11	1.69	0.111	-0,41
Final heart rate (bpm)	186±5	182±10	1.07	0.299	-0.26
Heart rate 1-min (bpm)	167±12	165±15	0.31	0.758	-0.07
SJFT Index (bpm/throw)	14.12 ±1.01	12.74±1.01	2.52	0.02	-0.62

Table 4. Correlation between Special Judo Fitness Test performance, Wingate test performance and body composition and between fat free mass and heart rate (A/B/C) of male and female judo athletes

	Total throws	Index	SJFT A	SJFT B	SJFT C	PP	MP	HRA	HRB	HRC
PP	0.79	-0.69	0.81	0.62	0.79	-	-	-	-	-
MP	0.80	-0.87	0.76	0.72	0.75	0.78	-	-	-	-
Fat mass	-0.71	0.68	-0.56	-0.62	-0.75	-0.59	-0.61	-	-	-
Fat%	-0.71	0.80	-0.64	-0.59	-0.74	-0.77	-0.71	-	-	-
Fat free mass	-	-	-	-	-	-	-	-0.56	-0.57	-0.51

PP = peak power; MP = mean power; SJFT = Special Judo Fitness Test; A, B and C = throws during sets of the SJFT, with 15 s, 30 s and 30 s, respectively; significant correlation between variables (p<0.01);HR= heart rate; A, B and C = sets of the SJFT, with 15 s, 30 s and 30 s, respectively (p<0.05)

gate and SJFT performance. Moreover, large negative correlation was found between fat free mass and HRA, HRB and HRC.

Discussion

The main findings of the present study were: (1) female judo athletes were shorter, presented lower fat-free mass, and higher body fat percentage compared to males, all with moderate effect sizes; (2) peak and mean power were higher for males compared to females, with moderate effect sizes; (3) a higher SJFT index – with moderate effect size – was observed in females compared to males;

(4) significant, large and very large, positive correlations were found between Wingate and SJFT variables, while body fat was large and very large negatively correlated to Wingate and SJFT performances.

The differences in height, fat-free mass and body fat percentage observed in our study are similar to those reported in previous studies comparing male and female judo athletes from Canada [Little 1991], Croatia [Sertic *et al.* 2006], USA elite athletes [Callister *et al.* 1990; Callister *et al.* 1991], Brazilian University Team [Franchini *et al.* 1998], Brazilian Olympic Team [Koury *et al.* 2007]. The values observed in these investigations are lower than the ones found in the present study for males, as the body fat percentage for males varied from

7.0 ± 3.0% in the Brazilian Olympic Team [Koury *et al.* 2007] to 12.0 ± 1.2% for Croatians [Sertic *et al.* 2006], while the values for females in our study were higher than reported in elite USA athletes (15.2 ± 1.0%, Callister *et al.* 1991; 15.8 ± 1.2%, Callister *et al.* 1990), Canadians (15.2 ± 2.1%, Little 1991), those from Brazilian University Team (16.1 ± 3.0%, Franchini *et al.* 1998) and Croatians (16.6 ± 4.3%, Sertic *et al.* 2006), but similar to those from the Brazilian Olympic Team [Koury *et al.* 2007]. However, as previously suggested [Franchini *et al.* 2011], caution is needed concerning the use of such values, as most studies predicted body fat by skinfold thickness measurements, differently from the method used in our study, and the specific typical error of each equation or method should be taken into account.

The higher Wingate peak and mean power in male compared to female judo athletes have been reported previously, and typically females present approximately 70% of those observed in males [Franchini *et al.* 2011]. This difference is attributed to higher glycolytic participation (35%) during the Wingate test in males compared to females, and higher aerobic contribution (7%) in females compared to males [Hill, Smith 1993]. However, in the present study the values achieved by females were 81.9% and 81.5% of the peak and mean power, respectively, achieved by males. Indeed, the only study comparing male and female Olympic judo athletes also found that female performances were closer to those from males (78.5% for peak power and 79.6% for mean power) (Sbriccoli *et al.*, 2007), suggesting that when top-level judo athletes are analyzed the difference between male and females is lower than that observed in other groups of judo athletes [Franchini *et al.* 2011] or in the general population [Inbar *et al.* 1996].

The index in the SJFT is considered a mixture of anaerobic and aerobic fitness, with higher participation of the glycolytic system [Franchini *et al.* 2011]. Considering the differences revealed in the Wingate test performance, it is probable that the better index observed in males compared to females is more related to the higher anaerobic fitness of the first group compared to the latter. Although we are not aware of any study comparing the energy system participation during the SJFT in male and female high-level athletes, a similar explanation concerning the energy system participation during the SJFT (i.e., higher glycolytic and lower oxidative participation in males compared to females) as observed in the Wingate test [Hill, Smith 1993] may apply. A recent meta-analysis of male and female judo athletes, found no significant difference between these groups concerning the index [Sterkowicz-Przybycien *et al.* 2017]. However, the performance of our female athletes would be classified as poor when the normative table developed by Sterkowicz-Przybycien and Fukuda [2014] for senior female judo athletes is considered, while the classification for the male athletes tested is good, when

the normative table developed by Franchini *et al.* [2009] is considered. Thus, part of the differences between the sexes can be attributed to a lower competitive level of the female judo athletes herein evaluated than for our male judo athletes compared to international standard established for each sex.

Finally, the correlations found in our study are similar to previously reported studies in the literature [Arazi *et al.* 2017; Casals *et al.* 2017; Franchini *et al.* 2007; Franchini *et al.* 2009; Kim *et al.* 2011], and indicate that lower body fat percentage and increased fat-free mass are relevant to judo athletes anaerobic performance [Arazi *et al.* 2017; Franchini *et al.* 2005; Kim *et al.* 2017] and a mixture of anaerobic and aerobic performance measured in the SJFT [Arazi *et al.* 2017; Franchini *et al.* 2007]. This is also especially relevant, as body fat was negatively correlated with total number of attacks ($r = -0.76$), and total work in two upper-body Wingate test was negatively correlated to number of attacks ($r = -0.76$) during the match [Franchini *et al.* 2005]. Moreover, previous studies [Drid *et al.* 2012; Franchini *et al.* 2009] indicated a positive relationship between Wingate and SJFT variables, probably due to the fact that both tests rely predominantly on anaerobic pathways [Franchini *et al.* 2011].

Conclusion

This study determined the relationship between physical characteristics and SJFT and WanT performances of elite judo athletes from Turkish Olympic team. We found that female judo athletes were shorter, presented lower fat-free mass, and higher body fat percentage, presented lower peak and mean power and higher (worse) SJFT compared to males. Moreover, large and very large, positive and significant correlations were found between Wingate and SJFT variables, while body fat was large and very large negatively correlated to Wingate and SJFT performances.

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Profil antropometryczny, test wydolności (Wingate) i specjalny test sprawdzający poziom umiejętności judo tureckich olimpijczyków

Słowa kluczowe: judo, pomiar antropometryczny, specjalne testy judo

Abstrakt

Tło. Judo to sport olimpijski, w którym ważna jest sprawność fizyczna, a także technika i taktyka. Warunki fizyczne i fizjo-

logiczne sportowców są bardzo ważne dla osiągnięcia lepszych wyników w *judo* i nadal istnieje zapotrzebowanie na więcej danych związanych z tymi determinantami.

Problem i cel. Potrzebne są dalsze dane dotyczące uwarunkowań antropologicznych judoków. W związku z tym, celem niniejszego badania było dokonanie oceny profilu antropometrycznego, przy zastosowaniu testów sprawdzających sprawność (Wingate i Special Judo Fitness Test).

Metody. W celu zbadania profilu antropometrycznego przeprowadzono następujące testy i pomiary: test *Wingate* i *Special Judo Fitness Test* (SJFT) dla zawodników ($n = 7$) i zawodniczek ($n = 10$) z tureckiej drużyny olimpijskiej w *judo*. Do porównania sportowców płci męskiej i żeńskiej wykorzystano niezależny *t-test*. W celu zweryfikowania zależności między zmiennymi zastosowano korelację liniową Pearsona. Siłę relacji między dwiema zmiennymi w populacji statystycznej obliczono zgodnie z zaleceniami Rhea (2004).

Wyniki. Zanotowano różnice między sportowcami płci męskiej i żeńskiej w następujących zmiennych: beztłuszczowa masa, procent tkanki tłuszczowej, moc szczytowa i średnia, tętno (HR) w zbiorze A i indeks SJFT ($p < 0,05$). Znalaziono duże i bardzo duże korelacje między pomiarami antropometrycznymi, parametrami SJFT i wynikami wydajności WanT ($p < 0,01$). Stwierdzono dużą korelację pomiędzy beztłuszczową masą a wartościami tętna podczas testu SJFT ($p < 0,05$).

Wnioski. Można stwierdzić, że im wyższy procent tkanki tłuszczowej, tym niższe są czynności związane z przemieszczeniem ciała. Należy wziąć pod uwagę różnice płci i masy ciała podczas oceniania sportowców *judo*, a ponieważ masa o wyższej zawartości tłuszczu oznacza lepszą wydajność w czasie testu SJFT, Program szkolenia powinien być zorganizowany w celu zmniejszenia lub utrzymania poziomu tkanki tłuszczowej i zwiększenia masy mięśniowej.