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Anthropometrical Profile of Judo Athletes: Comparative Analysis Between Weight Categories

Perfil Antropométrico de Atletas de Judo: Análisis Comparativo entre Categorías de Peso

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SUMMARY: This study compared the anthropometrical characteristics in judo athletes of different weight categories. The sample was composed by 104 Brazilian male judo athletes of national/international level from all seven official weight categories: extra-lightweight (-60 kg; n = 16), half-lightweight (-66 kg; n = 12), lightweight (-73 kg; n = 24), half-middleweight (-81 kg; n = 25), middleweight (-90 kg; n = 15), half-heavyweight (-100 kg; n = 7) and heavyweight (+100 kg; n = 5). The following anthropometric measurements were carried out: body mass, height, skinfold thickness (triceps, subscapular, suprailiac, abdominal, front thigh, and medial calf), circumferences (chest, relaxed arm, flexed arm, forearm, wrist, proximal thigh, medial calf and ankle) and breadth (humerus and femur epicondyles, biacromial, chest, chest depth, and biliocristal). The somatotypes for seven weight categories were calculated with three-dimensional approach. An one-way analysis of variance and Tukey test were used to compare groups concerning normally distributed data, while the Kruskal-Wallis test was used for non-normally distributed data ($P<0.05$). The main results of the present study were: (1) height differed across non subsequent weight categories, except for the difference between -60 kg and -66 kg; (2) for all the skinfold thickness the four lightest categories did not differ among them, and the +100kg group presented higher values compared to all other weight categories; (3) for most of the circumferences the -60 kg and -66 kg groups presented lower values compared to the three heaviest weight categories (-90 kg, -100 kg and +100 kg); (4) somatotype categories were similar in the three lightest groups (-60 kg, -66 kg, -73kg), while the heaviest category differed from all other groups; (5) most of the differences among groups appeared in the bone breadth measurements. Thus, the main differences between weight categories are the bone breadths and circumferences, whilst height and skinfold thickness are variables that differ mainly between heavier and lighter categories.

KEY WORDS: Combat sports; Skinfold thickness; Bone diameters; Circumferences; Somatotype.

INTRODUCTION

Judo is a weight-classified, high-intensity combat sport where the athlete attempts to throw the opponent onto his/her back or to control him/her during groundwork combat (Franchini *et al*., 2011a, 2011b; Franchini *et al*., 2007; Franchini *et al*., 2005a). The aim of weight division is to ensure fairness and promote even-handed combats in terms of strength, leverage and agility. However, judo athletes usually try to maximize muscle mass and to minimize adiposity in each weight category to gain an advantage over weaker opponents (Artioli *et al*., 2010; Brito *et al*., 2012; Franchini *et al*., 2012). An exception is the +100 kg division, where no body mass upper limit is given. Some studies reported that to be successful judo athletes need high levels of upper-body anaerobic power and capacity, strength and muscle power (Franchini *et al*., 2005b, 2011b; Kim *et al*., 2011; Little, 1991). Thus, the body structure can play a determining role in the achievement of top judo performance (Claessens *et al*., 1987; Krstulovic *et al*., 2006; Sterkowicz-Przybycien & Franchini, 2013), and it seems to influence the type of techniques applied (Franchini *et al*., 2005a). Furthermore, body fat has been reported to be negatively associated with judo athletes performance in both aerobic and anaerobic tests (Franchini *et al*., 2005a; Kim *et al*.). Therefore, several studies have aimed to obtain anthropometrical parameters, such as body composition, bone diameter and circumferences, due to their utmost importance for performance (Claessens *et al*.; Franchini *et al*., 2005a, 2007; Kubo *et al*., 2006). Callister *et al*. (1991) reported lower fat mass in higher-ranked judo athletes, compared with non-high level athletes (5.1% ± 0.6% vs.

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8.2% ± 0.8%). Additionally, Kubo *et al*. demonstrated that judo athletes who participated in the Olympic Games or Asian Games had significantly larger fat-free mass than university judo athletes who did not participate in intercollegiate competitions. Franchini *et al*. (2005b) did not find any significant difference in skinfold thickness between elite and nonelite judo athletes, but identified higher circumference values (flexed arm, forearm, wrist and medial calf) and breadths (humerus and femur epicondyles) in elite when compared to nonelite athletes. However, when the competitive level of the athlete is closer (national team members and their reserves) no anthropometrical difference was found (Franchini *et al*., 2007). Although some studies (Claessens *et al*.; Farmosi, 1980) compared judo athletes from different weight categories, they were limited to two non-official category divisions (light and heavy athletes). Other studies compared the official weight divisions, but they were limited to only one variable (e.g., body fat) (Iida *et al*., 1998) or were conducted with Cadet athletes (Pérez & Sanagua, 1996). Thus, the purpose of this study was to compare anthropometrical variables in male judo athletes of all seven weight categories.

MATERIAL AND METHOD

Participants. The sample was composed by 104 Brazilian male judo athletes of national/international level from all seven official categories: extra-lightweight (-60 kg; n= 16), half-lightweight (-66 kg; n= 12), lightweight (-73 kg; n= 24), half-middleweight (-81 kg; n= 25), middleweight (-90 kg; n= 15), half-heavyweight (-100 kg; n= 7) and heavyweight (+100 kg; n= 5). All participants took part voluntarily in the study after being informed about the procedures involved (risks and benefits), and signed an informed consent agreement form. All the procedures were previously approved by the local Ethics Committee. All the athletes were at the competitive period and were not engaged in any weight loss procedure at the week of the measurements. Their competitive level varied from regional to international.

Anthropometrical Measurements. The following anthropometric measurements were carried out: body mass, height, skinfold thickness (triceps, subscapular, suprailiac, abdominal, front thigh, and medial calf), circumferences (chest, relaxed arm, flexed arm, forearm, wrist, proximal thigh, medial calf and ankle) and breadth (humerus and femur epicondyles, biacromial, chest, chest depth, and biiliocristal). Skinfold thickness measurements were carried out three times on each point in a rotation system, as described by Heyward (2007). A researcher with more than 10 years of experience in this measurement procedure carried it out, presenting a variation of less than 2% between measurements, with reproducibility determined by an intra-class correlation coefficient of 0.98, within the assessment period. The breadths and circumferences were measured only once at each point by the same experienced evaluator, who presented less than 1% of variation between measurements and an intra-class correlation coefficient of 0.99. The somatotypes for seven weight categories were calculated using the three dimensional approach (Carter & Heath, 1990) and the somatotype attitudinal distance, which is the difference between somatopoints (points in three dimensional space representing somatotypes) was calculated in component units.

Statistical Analysis. Data are presented as mean ± standard deviation or as median and quartiles depending on the data distribution. The Levene's test was used to access the equality of variances. An one-way analysis of variance and Tukey test were used to compare groups when the equality of variances assumption was confirmed and the Kruskal-Wallis one-way analysis of variance test followed by test for multiple comparison of mean ranks were used when data normality was not found. Effect sizes η^2 were also calculated. The level of significance was set at 5%. All analyses were conducted using Statistica 10.

RESULTS

Table I presents judo athletes age and height from different weight categories. Athletes did not differ in age. Height differed across non-subsequent weight categories, except for the difference between -60 kg and -66 kg and -100 and +100 kg, which were different. The -81 kg also did not differ from the -100 kg.

Table II presents the skinfold thickness results of judo athletes from different weight categories. For skinfold thickness, the differences were found between the two lightest weight categories (-60 kg and -66 kg) and the three heaviest weight categories (-90 kg, -100 kg and +100 kg). A good indicator of this result is the sum of six skinfolds thickness measured, in which the -60 and -66 kg presented lower values than the -90 kg, -100 kg and +100 kg weight categories. Furthermore, the -73 kg and -81 kg groups also presented lower values than the +100 kg weight category.

Table III presents the circumferences of judo athletes from different weight categories. The three lightest categories did not differ among them in relaxed arm circumference, whilst the four heaviest weight categories did not differ

Table I. Age (years) and height (cm) of male judo athletes from different weight categories (data are mean ± standard deviation).

Variable	-60 kg (n = 16)	-66kg (n = 12)	-73kg (n = 24)	-81kg (n = 25)	-90kg (n = 15)	-100kg (n = 7)	+100kg (n = 5)	Statistics
Age (years)	22.8±3.8	21.5±2.8	22.2±4.1	22.4±3.1	24.5±4.2	25.3±4.1	24.4±3.9	$F = 1.6$, $P = 0.158$, $\eta^2 = 0.09$
Height (cm)	163.3±4.6[b-g]	171.6±3.9[a,d-g]	174.2±4.9[a,e,g]	177.2±4.2[a,b,f,g]	181.3±5.3[a-c,g]	181.6±7.4[a-b,g]	192.5±7.0[a-f]	$F = 33.0$, $P < 0.001$, $\eta^2 = 0.67$

a= different from -60 kg; b= different from -66 kg; c= different from -73 kg; d= different from-81 kg; e= different from -90 kg; f= different from -100 kg; g= different from +100 kg (P<0.05).

Table II. Skinfold thickness (mm) in male judo athletes from different weight categories (data are median and percentiles 25th and 75th).

Site	-60 kg (n = 16)	-66 kg (n = 12)	-73 kg (n = 24)	-81 kg (n = 25)	-90 kg (n = 15)	-100 kg (n = 7)	+100 kg (n = 5)	Statistics
Triceps (mm)	6.2 (4.5;7.7)[f-g]	6.9 (5.5;8.1)[g]	6.8 (5.3;9.8)[g]	7.4 (5.4;8.4)[g]	8.8 (7.0;10.3)	8.4 (8.2;17.0)[a]	22.0 (19.0;24.0)[a-d]	$H = 27.9$, $P = 0.001$, $\eta^2 = 0.55$
Subscapular (mm)	9.3 (7.9;10.2)[e-g]	9.1 (7.9;10.2)[e-g]	10.0 (8.4;12.8)[e-g]	10.2 (9.4;14.6)[g]	14.2 (12.6;22.0)[a-c]	22.0 (13.2;28.0)[a-c]	37.0 (28.0;40.0)[a-d]	$H = 45.5$, $P < 0.001$, $\eta^2 = 0.55$
Abdominal (mm)	8.2 (6.8;11.2)[e-g]	9.6 (7.3;11.0)[e-g]	11.8 (8.6;19.6)[g]	12.0 (9.6;16.5)[g]	22.2 (13.2;28.4)[a-b]	23.0 (19.6;29.6)[a-b]	43.2 (39.0;45.0)[a-d]	$H = 45.2$, $P < 0.001$, $\eta^2 = 0.56$
Suprailiac (mm)	6.1 (4.9;7.3)[e-g]	6.0 (4.8;6.8)[e-g]	7.1 (5.1;10.3)[g]	7.0 (6.0;8.8)[g]	10.8 (6.9;15.2)[a-b]	13.0 (9.0;25.0)[a-b]	32.0 (31.0;34.0)[a-d]	$H = 37.0$, $P < 0.001$, $\eta^2 = 0.66$
Proximal thigh (mm)	8.8 (6.5;9.7)[e-g]	13.3 (7.2;15.3)[g]	12.8 (9.2;16.5)[g]	10.8 (9.5;16.0)[g]	16.2 (11.8;24.8)[a]	18.0 (15.0;31.0)[a]	37.0 (35.0;39.0)[a-d]	$H = 40.1$, $P < 0.001$, $\eta^2 = 0..55$
Medial calf (mm)	4.9 (4.1;6.0)[e-g]	6.6 (5.3;7.4)[g]	7.0 (4.9;7.9)[g]	7.2 (6.0;8.0)[g]	9.2 (6.0;11.0)[a]	12.4 (9.0;16.6)[a]	31.0 (30.0;36.0)[a-d]	$H = 41.7$, $P < 0.001$, $\eta^2 = 0.74$
Sum of skinfold thickness (mm)	44.8 (37.9;54.5)[e-g]	52.2 (40.5;57.4)[e-g]	61.0 (40.5;73.6)[g]	52.9 (48.0;74.1)[g]	87.0 (61.4;121.3)[a-b]	119.2 (77.4;146.0)[a-b]	194.0 (189.0;213.5)[a-d]	$H = 46.1$, $P < 0.001$, $\eta^2 = 0.71$

a= different from -60 kg; b= different from -66 kg; c= different from -73 kg; d= different from-81 kg; e= different from -90 kg; f= different from -100 kg; g= different from +100 kg (P<0.05).

Table III. Circumferences (cm) of male judo athletes from different weight categories (data are mean ± standard deviation for parametric and median and percentiles 25th and 75th for non-parametric distributions).

Circumference	-60 kg (n = 16)	-66 kg (n = 12)	-73 kg (n = 24)	-81 kg (n = 25)	-90 kg (n = 15)	-100 kg (n = 7)	+100 kg (n = 5)	Statistics
Relaxed arm (cm)	28.6 (27.8;29.9)[d-g]	29.8 (28.2;31.6)[d-g]	30.9 (29.3;31.4)[d-g]	33.2 (32.5;34.0)[a-c,f-g]	33.9 (32.5;35.1)[a-c,g]	36.0 (35.0;37.0)[a-c,g]	40.0 (36.5;40.6)[a-f]	$H = 68.2$, $P < 0.001$, $\eta^2 = 0.64$
Flexed arm (cm)	31.3±2.1[d-g]	32.2±2.2[d-g]	33.2±1.8[d-g]	36.0±1.8[a-c,f,g]	37.1±2.0[a-c,f,g]	40.3±1.0[a-e]	43.4±3.0[a-e]	$F = 46.0$, $P < 0.001$, $\eta^2 = 0.74$
Forearm (cm)	26.0 (24.9;26.5)[c-g]	27.1 (26.3;27.5)[d-g]	28.0 (27.0;28.9)[e-g]	29.7 (28.5;30.1)[a-b]	30.5 (29.2;31.0)[a-c]	32.5 (31.2;32.6)[a-c]	35.1 (35.0;38.1)[a-c]	$H = 45.5$, $P < 0.001$, $\eta^2 = 0.66$
Thorax (cm)	83.3 (79.8;86.6)[d-g]	87.8 (85.8;90.9)[d-g]	89.5 (87.6;90.4)[d-g]	94.0 (92.5;95.4)[a-c]	96.5 (94.0;101.0)[a-c]	102.7 (101.0;105.9) [a-c]	117.3 (109.8;122.0)[a-c]	$H = 78.9$, $P < 0.001$, $\eta^2 = 0.66$
Proximal thigh (cm)	51.7±3.7[c-g]	54.3±2.2[d-g]	55.5±2.0[a,e-g]	58.9±2.6[a-c,e-g]	62.3±2.9[a-c,f,g]	67.3±3.6[a-e,g]	71.6±6.0[a-f]	$F = 65.2$, $P < 0.001$, $\eta^2 = 0.80$
Medial calf (cm)	33.5 (30.2;36.3)[c-g]	35.9 (35.0;37.4)[e-g]	37.0 (36.0;38.2)[a-e-g]	38.5 (37.0;39.0)[a]	40.0 (38.5;42.5)[a-c]	42.7 (41.5;44.5)[a-c]	48.5 (45.2;52.6)[a-c]	$H = 68.7$, $P < 0.001$, $\eta^2 = 0.74$

a= different from -60 kg; b= different from -66 kg; c= different from -73 kg; d= different from-81 kg; e= different from -90 kg; f= different from -100 kg; g= different from +100 kg (P<0.05).

Table IV. Bone breadths (cm) of male judo athletes from different weight categories (data are mean ± standard deviation for parametric and median and percentiles 25th and 75th for non-parametric distributions).

Bone diameters	-60 kg (n = 16)	-66kg (n = 12)	-73kg (n = 24)	-81kg (n = 25)	-90kg (n = 15)	-100kg (n = 7)	+100kg (n = 5)	Statistics
Biacromial (cm)	$38.1\pm1.9^{d,e,g}$	$38.7\pm1.9^{e,g}$	39.4 ± 3.0^{e}	40.8 ± 2.6^{a}	$42.6\pm1.2^{a-c}$	41.3 ± 2.2	$43.6\pm3.1^{a-b}$	$F = 8.0$, $P < 0.001$, $\eta^2 = 0.33$
Transverse of thorax	$26.6\pm1.7^{d-g}$	$27.3\pm2.0^{e-g}$	$28.0\pm1.6^{f,g}$	$29.3\pm1.9^{a,g}$	$29.6\pm1.1^{a,b,g}$	$31.0\pm2.0^{a-c}$	$34.2\pm1.7^{a-e}$	$F = 17.8$, $P < 0.001$, $\eta^2 =$
Ant.-post of thorax (cm)	$17.1\pm1.6^{e-g}$	$19.7\pm3.1^{f,g}$	$18.9\pm1.8^{f,g}$	$19.4\pm3.3^{f,g}$	21.0 ± 1.7^{a}	$23.7\pm4.1^{a-d}$	$24.2\pm4.0^{a-d}$	$F = 12.1$, $P < 0.001$, $\eta^2 =$
Biiliocristal (cm)	25.0 $(24.0;26.2)^{d-g}$	26.1 $(25.0;26.7)^{e-g}$	27.0 $(26.0;27.1)^{g}$	28.0 $(26.0;29.0)^{a}$	28.0 $(28.0;29.0)^{a-b}$	28.2 $(28.0;29.1)^{a-b}$	34.3 $(31.5;34.4)^{a-c}$	$H = 47.7$, $P < 0.001$, $\eta^2=0.58$
Epicondyle femoral	$9.1\pm0.4^{c-g}$	$9.5\pm0.5^{e-g}$	$9.7\pm0.5^{a,e-g}$	$9.8\pm0.4^{a,f-g}$	$10.3\pm0.5^{a-c,g}$	$10.4\pm0.5^{a-d,g}$	$11.5\pm0.7^{a-f}$	$F = 27.6$, $P < 0.001$, $\eta^2 =$
Epicondyle humeral	$6.5\pm0.2^{c-g}$	$6.8\pm0.1^{d,e,g}$	$7.0\pm0.4^{a,e,g}$	$7.3\pm0.5^{a,b,g}$	$7.5\pm0.3^{a-c,g}$	$7.4\pm0.3^{a,g}$	$8.3\pm0.5^{a-f}$	$F = 19.3$, $P < 0.001$, $\eta^2 =$

a= different from -60 kg; b= different from -66 kg; c= different from -73 kg; d= different from-81 kg; e= different from -90 kg; f= different from -100 kg; g= different from +100 kg ($P<0.05$).

Table V. Somatotype components (somatotype unit) of male judo athletes from different weight categories (data are mean ± standard deviation for parametric and median and percentiles 25th and 75th for non-parametric distributions).

Somatotype	-60 kg (n = 16)	-66kg (n = 12)	-73kg (n = 24)	-81kg (n = 25)	-90kg (n = 15)	-100kg (n = 7)	+100kg (n = 5)	Statistics
Endomorphy	2.3 $(1.9;2.5)^{e-g}$	2.1 $(1.7;2.5)^{e-g}$	2.6 $(1.7;3.1)^{g}$	2.3 $(2.0;3.1)^{g}$	3.6 $(2.5;4.5)^{a-b}$	4.3 $(2.9;6.1)^{a-b}$	7.2 $(6.6;7.7)^{a-d}$	$H = 36.3$, $P < 0.001$, $\eta^2 = 0.52$
Mesomorphy	5.5 $(5.1;6.0)^{f-g}$	5.0 $(4.5;6.1)^{f-g}$	5.4 $(4.8;6.2)^{f-g}$	6.3 $(5.4;6.7)$	6.4 $(5.7;7.5)$	7.6 $(7.3;7.8)^{a-c}$	8.2 $(8.2;9.6)^{a-c}$	$H = 37.8$, $P < 0.001$, $\eta^2 = 0.38$
Ectomorphy	2.0 $(1.5;2.7)^{f-g}$	1.9 $(1.9;2.9)^{e-g}$	2.0 $(1.6;2.7)^{e-g}$	1.6 $(1.2;2.0)$	1.0 $(0.8;1.9)^{b,c}$	0.8 $(0,1;1.1)^{a-c}$	0.1 $(0.1;01)^{a-c}$	$H = 40.8$, $P < 0.001$, $\eta^2 = 0.34$
Somatotype mean	$2.3\text{-}5.2\text{-}2.2^{d-g}$	$2.3\text{-}5.2\text{-}2.3^{d-g}$	$2.7\text{-}5.4\text{-}2.1^{e-g}$	$2.6\text{-}6.1\text{-}1.6^{a-b,e-g}$	$3.7\text{-}6.6\text{-}1.2^{a-d,g}$	$4.7\text{-}7.5\text{-}0.7^{a-e,g}$	$7.2\text{-}8.6\text{-}0.1^{a-f}$	$F = 15.37$, $P < 0.001$, $\eta^2 = 0.48$
Somatotype SD	0.5-1.1-1.1	0.8-1.0-0.8	1.2-0.9-0.8	0.8-1.0-0.6	1.3-1.1-0.7	1.8-0.8-0.4	0.7-1.6-0.0	

a= different from -60 kg; b= different from -66 kg; c= different from -73 kg; d= different from-81 kg; e= different from -90 kg; f= different from -100 kg; g= different from +100 kg ($P<0.05$).

among them. The four heaviest categories presented higher values compared to the three lightest ones.

For the flexed arm circumference, the -60 kg, -66 kg and -73 kg groups presented lower values compared to the four heaviest weight categories, whilst the -100 and +100 kg presented higher values compared to the categories below -90 kg.

Concerning forearm circumference, the two lightest groups presented lower values compared to the four heaviest ones and the -73 kg group presented lower values compared to the three heaviest.

For thorax circumference, the three lightest weight categories presented lower values compared to the four heaviest ones.

The thigh circumference was smaller in the three lightest groups compared to that from the three heaviest ones. Additionally, the -60 kg also presented lower values compared to -73 and -81 kg groups.

Table IV presents bone breadths of judo athletes from different weight categories. For biacromial breadth the -60kg group presented lower values compared to –81 kg, -90 kg and +100 kg weight categories, and the -66 kg presented lower values compared to +100kg. Additionally, the -90 kg group had higher biacromial breadths compared to all categories below 73 kg.

The -60 kg group presented lower transverse of thorax breadth compared to the five heaviest weight categories, while the -66kg presented lower values compared to the four heaviest. The +100 kg presented higher value compared to the five lightest weight categories and the -100 kg presented higher value compared to the three lightest.

For the antero-posterior thorax breadth, the two heaviest weight categories presented higher values compared to -60 kg, -66 kg, -73 kg and -81 kg, whilst the -90 kg also presented higher values than the -60 kg.

For the biliocristal breadth, the -60 kg group presented lower values compared to the four heaviest weight categories, whilst the -66 kg presented lower values compared to the three heaviest ones. Additionally, the -73 kg group presented lower values compared to the +100 kg group.

The +100 kg group presented higher epicondyle femoral breadth compared to all other weight categories, whilst the -90 kg and -100 kg had higher values compared to the three lightest weight categories. Additionally, the -60kg group presented lower values compared to -73 kg and -81 kg groups.

For the epicondyle humeral breadth the +100 kg group presented higher values compared to all weight categories, whilst the -90kg group had higher value compared to the three lightest weight categories. Additionally, the -60 kg weight category had lower value compared to -73 kg, -81 kg and -100 kg groups, whilst the -66 kg group presented lower value compared to the -81kg group.

Table V presents the somatotype components of judo athletes from different weight categories. In all three somatotype components significant differences between the two lightest and the two heaviest categories were observed. The two heaviest categories had highest endomorphy and mesomorphy, but lowest ectomorphy. Representatives from three middle categories did not differ from the lightest or heaviest weight categories.

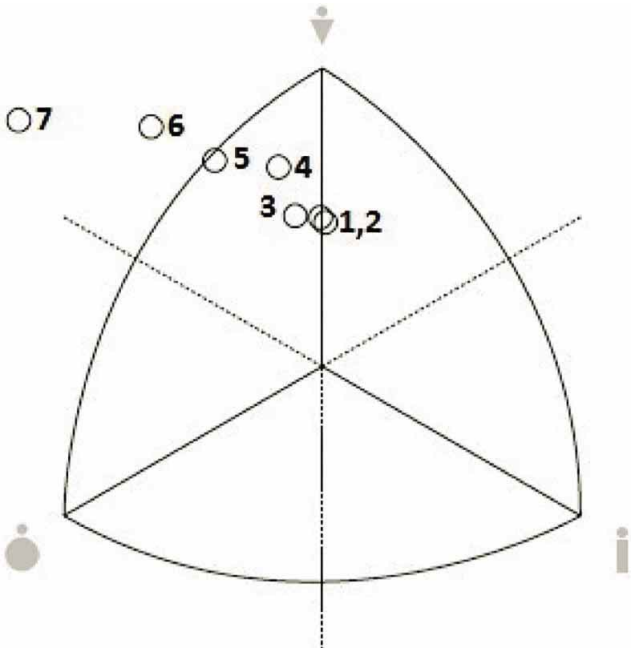

Fig. 1. Somatochart representation for the athletes from the seven weight categories. 1= -60 kg; 2= -66 kg; 3= -73 kg; 4= -81 kg; 5= -90 kg; 6= -100 kg; 7= +100 kg.

Somatotype attitudinal distance differed between groups ($F= 15.37$, $P<0.001$; $\eta^2= 0.48$). In general, the mean somatotype (3.6-6.4-1.5) was identified as endomorphic-mesomorph. This somatotype was typical in three middle and two heaviest categories. However, it was not the case of -60 kg (2.3-5.2-2.2) and -66 kg (2.3-5.2-2.3). Somatopoints for them were located in the balanced-mesomorph region (Fig. 1).

Comparison in each pairs of somatotype categories showed that the three lightest groups (-60 kg, -66 kg, -73 kg) presented a homogeneous composition. The -81kg group somatotype did not differ from -73kg group, as well as -90 kg and -100 kg groups presented similar somatotypes. The heaviest category differed from all other groups. Somatotype attitudinal distance was biggest (4.4 somatotype units) for +100 kg category and smallest (0.3) for the -90 kg category, which did not differ from total mean. For all other weight categories the somatotype attitudinal distance values were from 1.2-2.0 somatotype units. Somatotype points of the judo athletes (Fig. 1) were classified in seven types: mesomorphic-endomorph (n= 1), mesomorph-endomorph (n= 7), endomorph-mesomorph (n= 49), balanced-mesomorph (n= 32), ectomorphic-mesomorph (n= 12), mesomorph-ectomorph (n= 2) and mesomorphic-ectomorph (n= 1), while one subject presented a very unusual characteristic (2.4-2.9-4.3), i.e., in an unknown somatoplot region.

DISCUSSION

The objective of the present study was to characterize and compare anthropometrical variables in male judo athletes in each of the seven official weight categories. The main results of the present study was that: (1) height differed across non subsequent weight categories, except for the difference between -60 kg and -66 kg; (2) for all the skinfold thickness the four lightest categories did not differ among them, and the +100 kg group presented higher values compared to all other weight categories; (3) The three lightest categories did not differ among them in relaxed arm circumference, whilst the four heaviest weight categories did not differ among them. The four heaviest categories presented higher values compared to the three lightest ones. For most of the circumferences the -60 kg and -66 kg groups presented lower values compared to the three heaviest weight categories (-90 kg, -100 kg and +100 kg); (4) somatotype categories were similar in the three lightest groups (-60 kg, -66 kg, -73 kg), while the heaviest category differed from all other groups; (5) most of the differences among groups appeared in the bone breadth measurements. Thus, the main differences between weight categories are the bone breadths and

circumferences, whilst height and skinfold thickness are variables that differ mainly between heavier and lighter categories.

This study confirms previous results concerning the low-fat percentage in the lightest weight categories and the high values in the -100 kg and in the +100 kg weight categories (Franchini *et al*., 2011b). High circumference values were also observed in the different weight categories, suggesting that muscle development is a basic characteristic necessary to judo athletes or a consequence of judo training over years (Franchini *et al*., 2005b; Kim *et al*.).

The typical somatotype of judo athletes was endomorphic-mesomorph. Our findings are in agreement with results of 21 international samples where the mean somatotype identified was 2.7-6.3-1.6, with dominant mesomorphy and endomorphy greater than ectomorphy (Sterkowicz-Przybycien, 2012). This study confirmed previous findings in a recent literature review (Sterkowicz-Przybycien´) when the categories from -73 kg to +100 kg are considered, but not for the -60 kg and -66 kg weight categories, where the typical somatotype was balanced-mesomorph. An increment of endomorphy and mesomorphy in consecutive weight categories was observed, but not in ectomorphy, which decreased in heavier weight categories. Thus, finding people with the body proportionality presented by heavyweight judo athletes is very difficult in the population (Sterkowicz-Przybycien & Franchini) and the specific mechanical characteristics of judo techniques suitable for this weight category is also restricted compared to other weight categories (Sterkowicz *et al*., 2013). Research about the relationship between anthropometric measurements and technique performed in tournament is scarce (Marchocka, 1988), but suggest that competitors who frequently performed arm techniques (te-waza) were shorter than their counterparts from the same weight category who preferred leg techniques (ashi-waza). Thus, future studies should focus on the relationship between anthropometric characteristics and the techniques used by the athletes during competition.

CONCLUSION

This research presented the anthropometrical profile of male judo athletes. These results can be considered as a valuable referential for the different weight categories. The sample evidenced that judo athletes maintain their body mass in the upper weight limit of the category. Significant differences in skinfold thickness were found between two large groups: -60 kg and -66 kg groups and -100 kg and +100 kg groups, while the -73 kg and -81 kg did not differ from these two other groups. These results acknowledge previous research that characterized a small fat mass in judo athletes, except for the heavyweight category. Nevertheless, the lightest the category, the more it is characterized by a little subcutaneous skinfold thickness. Furthermore, statistical analysis of circumferences and bone diameters demonstrated a linear increase from the light to the heavyweight categories. Somatotype categories were similar in the three lightest groups (-60 kg, -66 kg, -73 kg), while the heaviest category differed from all other groups. Morphologically, athletes could be grouped in four divisions: from -60 kg and -66 kg; -73 kg and -81 kg; -90 kg and -100 kg and +100 kg. Additionally, it is recommended that future studies be conducted to compare different categories and the relationship between anthropometrical, championship performance and functional variables such as muscle power, muscle endurance, anaerobic capacity and technique selection.

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FRANCHINI, E.; STERKOWICZ-PRZYBYCIEN, K. & TAKITO, M. Y. Perfil antropométrico de atletas de judo: Análisis comparativo entre categorías de peso. ***Int. J. Morphol., 32(1)***:36-42, 2014.

RESUMEN: Este estudio comparó las características antropométricas de atletas de judo de diferentes categorías de peso. La muestra estuvo compuesta por 104 judocas hombres brasileños de nivel nacional/internacional de las siete categorías oficiales de peso: superligero (-60 kg; n = 16), semiligero (-66 kg; n= 12), ligero (-73 kg; n= 24), semimedio (-81 kg; n= 25), medio (-90 kg; n= 15), semipesado (-100 kg; n= 7) y pesado (+100 kg; n= 5). Se tomaron las siguientes medidas antropométricas: masa corporal, estatura, pliegues cutáneos (tríceps, subescapular, suprailíaco, abdominal, muslo frontal y pierna medial), circunferencias (pecho, brazo relajado, brazo contraído, antebrazo, muñeca, muslo proximal, pantorrilla y tobillo) y diámetros óseos (húmero y fémur, biacromial, pecho, profundidad del pecho y biliocristal). El somatotipo de los grupos de las siete categorías de peso se calculó mediante el método de tres dimensiones. Se utilizó un análisis unidireccional de varianza y la prueba de Tukey para comparar los grupos en aquellos datos distribuidos normalmente, mientras que se utilizo la prueba de Kruskal-Wallis en aquellos datos que no siguieron una distribución normal (P<0,05). Los principales resultados obtenidos fueron: (1) la altura difería en las categorías de peso no consecutivas, excepto entre las categorías de -60 kg y -66 kg; (2) los pliegues cutâneos de las cuatro categorías más ligeras no difirieron entre ellos, y el grupo de +100 kg presentó los valores más altos en comparación con las demás categorías de peso; (3) en la mayoría de circunferencias, los grupos de -60 kg y -66 kg presentaron valores más bajos en comparación con las tres categorías de mayor peso (-90 kg, -100 kg and +100 kg); (4) las categorías de somatotipo fueron similares en los tres grupos más ligeros (-60 kg, -66 kg,-73 kg), mientras que la categoría más pesada difirió del

resto de grupos; (5) la mayor parte de las diferencias entre los grupos se localizaron en los diámetros óseos. En conclusión, las principales diferencias entre las categorías de peso fueron los diámetros óseos y las circunferencias, mientras que la altura y espesor de los pliegues cutáneos variaron principalmente entre las categorías más ligeras y pesadas.

PALABRAS CLAVE: Deporte de combate; Pliegues cutáneos; Diámetros óseos; Circunferencias; Somatotipo.

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