

Proposal of a Normative Table for Classification of Body Fat Percentage in Brazilian Jiu-Jitsu Athletes

Propuesta de Tabla Normativa para la Clasificación del Porcentaje de Grasa Corporal en Atletas de Jiu-Jitsu Brasileño

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SUMMARY: Previous evidence indicates that body fat can distinguish Brazilian jiu-jitsu (BJJ) athletes according to the competitive level. However, propositions of cut-off points for establishing classifications of body fat percentage for combat sports athletes and, specifically, for BJJ athletes are still incipient in the literature. In this sense, the main aim of the present study was to establish a normative table for the classification of body fat percentage in BJJ athletes. As a secondary aim, athletes were compared according to competitive level. Ninety male BJJ athletes (aged: 29.0 ± 8.2 years; practice time: 6.0 ± 2.1 years; body mass: 82.1 ± 12.7 kg; height: 175.9 ± 6.5 cm; fat mass: 16.0 ± 8.9 kg; bone mineral content: 3.7 ± 0.6 kg; muscle mass: 37.9 ± 5.4 kg; body fat percentage: 17.3 ± 6.8 %; basal metabolic rate: 1811.4 ± 193.4 kcal) from different competitive levels: state ($n=42$), national ($n=26$) and international ($n=22$) took part in this study. All athletes had their body composition measured via tetrapolar bioelectrical impedance. Percentiles p10, p25, p50, p75, and p90 were used to establish the classification. As a result, the following classification was obtained: <7.7 % (very low); ≥ 7.7 – 11.5 % (low); 11.6 – 17.0 % (medium); 17.1 – 24.0 % (high) and ≥ 24.1 % (very high). State-level athletes had a higher fat percentage than national and international-level athletes ($p<0.05$). The proposed cut-off points can help professionals responsible for sports training and nutritional prescription in monitoring the body fat of BJJ athletes.

KEY WORDS: Martial arts; Sports performance; Combat sports; Body composition.

INTRODUCTION

Brazilian jiu-jitsu (BJJ) is a grappling combat sport, which is divided into different bodyweight classes (rooster, light-feather, feather, light, middle, medium-heavy, heavy, super-heavy, and ultra-heavy) (International Brazilian Jiu-Jitsu Federation, 2020). The premise is that athletes with lower body fat (%BF) and high musculoskeletal mass have greater success in BJJ competitions (Andreato *et al.*, 2017). It was explained that excessive body fat could negatively impact physical and sports performance in combat sports (Franchini *et al.*, 2005, 2007). Previous studies using a skinfold thickness indicate that the %BF in male BJJ

athletes oscillates between ~ 6.5 (da Silva *et al.*, 2015) and ~ 19.3 % (Báez *et al.*, 2014) according to the competitive level. On the other hand, studies that utilized bioelectrical impedance (BIA) to measure the %BF found values between ~ 9.1 to 15.7 % (Diaz-Lara *et al.*, 2014; Pietraszewska *et al.*, 2014; Øvretveit, 2018). Regarding studies published up to 2016 with BJJ, Andreato *et al.* (2017) identified that, on average, athletes present 12 % BF via skinfold thickness and BIA, whereas more recently, similar values were verified in BJJ athletes, i.e., ~ 13 %BF, using BIA (Øvretveit).

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Considering the listed aspects, Athayde *et al.* (2018), indicate that body fat negatively impacts countermovement jump performance in judo athletes. Kubo *et al.* (2006), found that Japanese Olympic athletes or participants in Asian judo games had higher fat free mass (FFM) than athletes participating or not participating in university competitions. Therefore, it is inferred that higher-level athletes in judo tend to have lower %BF than lower competitive level athletes. It is believed that in combat sports categorized by body weight, body fat tends to harm the athletes' performance. Hence, body adiposity must be controlled to establish the most appropriate weight category for the athlete (Andreato *et al.*, 2017).

Few studies have compared the %BF in BJJ athletes of different competitive levels (Andreato *et al.*, 2012; Brandão *et al.*, 2014; Marinho *et al.*, 2016). Andreato *et al.* (2012) and Brandão *et al.*, did not identify significant differences between the %BF in BJJ athletes according to the competitive level. Differently, Marinho *et al.* detected significant differences for %BF between elite and non-elite athletes in the BJJ. Then, considering that %BF may distinguish BJJ athletes according to the competitive level, establishing cut-off points for %BF classification could help physical trainers and nutritionists to determine which weight class would be most suitable for each athlete to compete.

Therefore, the aim of the present study was to establish a normative table for the classification of %BF in male athletes of BJJ of different competitive levels. As a secondary aim, the %BF of the athletes was compared according to the competitive level.

MATERIAL AND METHOD

Study design. This study presents a cross-sectional and observational design, carried out between 2017 and 2018 during the competitive period, to analyze the body composition of BJJ athletes and establish cut-off points for %BF.

Participants. Ninety male BJJ athletes from different competitive levels were recruited [blue-belt (n = 32), purple-belt (n = 25), brown-belt (n = 19), and black-belt (n = 14)], with athletes of all bodyweight classes: rooster, light-feather, feather, light, middle, medium-heavy, heavy, super-heavy, and ultra-heavy, by a heterogeneous sample: state level (n = 42), national (n = 26), and international (n = 22). BJJ athletes were 29.0 ± 8.2 years old and had an uninterrupted time of practice of the sport: 6.0 ± 2.1 years.

Inclusion and Exclusion Criteria. As inclusion criteria, the following were accepted: (1) athletes with ≥ 3 years of regu-

lar and systematic practice of BJJ; (2) participation in at least 1 official competition in the 6 months preceding the study; (3) train regularly ≥ 3 sessions of BJJ a week; (4) perform physical preparation concurrently with BJJ training. Exclusion criteria were: (1) athletes who used substances prohibited by the World Anti-Doping Agency (2015) and; (2) athletes who were in the process of losing weight. All athletes were informed about the study's objectives and were invited to sign the Informed Consent Form. The study was approved by the Ethics and Local Research Committee, under number 2091883/2017, following the Helsinki declaration.

Body composition and anthropometry. Before data collection, the athletes were instructed about the technical procedures for the assessment of body composition. Athletes received 7 days in advance an explanatory document on the preparation procedures for the assessment of body composition. Body mass and body composition were measured via tetrapolar BIA with eight electrodes (InBody, model 570®, BioSpace Ltd., Seoul, South Korea) with a capacity of 250 kg and 100 g accuracy. The athletes' height was measured using a wall-mounted stadiometer (Sanny, model ES2040, São Paulo, Brazil), with a accuracy of 0.1 cm.

All participants were instructed to carry out the following preparation to obtain the measurements: (1) fasting for four hours (without ingestion of solid or liquid food); (2) urinate before the assessment; (3) not performing moderate or vigorous physical activity 24 hours before the assessment; (4) do not drink caffeinated beverages 24 hours before the assessment; and (5) not to use diuretic medications 7 days before the assessment (Branco *et al.*, 2018b). The variables obtained in the BIA were: total body water (L), lean mass (kg), fat-free mass (kg), total body weight (kg), body fat mass (kg), bone mineral content (kg), musculoskeletal mass (kg), body mass index (kg/m^2), body fat percentage (%), basal metabolic rate (kcal), and lean mass balance, with right arm (kg), left arm (kg), trunk (kg), right leg (kg), and left leg (kg).

Statistical analysis. Descriptive statistics involved calculating the mean \pm standard deviation, minimum and maximum values, and confidence interval (95 % CI). The percentile proposition published by Branco *et al.* (2017, 2018a) was utilized for the establishment of the cut-off points for the %BF, which were: p10, p25, p50, p75, and p90, in line with previous studies with grappling combat sports (Branco *et al.*, 2017, 2018a). A t-test for unpaired samples was also applied to compare the practice time (3 years vs. > 3 years and < 6 years vs. ≥ 6 years) between %BF. Additionally, an analysis of variance (one-way ANOVA) was applied using Tukey's as a post hoc, in case a significant difference was found, to compare the athletes' competitive level and body mass. For all analyses, a

significance level of 5 % was assumed. All statistical analyzes were performed using the SPSS statistical package (Version 22.0, IBM, United States of America).

RESULTS

No significant differences were observed between the time of BJJ practice for %BF, i.e., athletes with 3 years vs. athletes with more than 3 years and athletes with < 6 years vs. athletes with more than 6 years ($p > 0.05$; both comparisons). Table I shows the general characteristics of the sample, with information on total body water, lean mass, fat-free mass, body mass, body fat mass, bone mineral content, musculoskeletal mass, body mass index, %BF, basal metabolic rate, right arm, left arm, trunk, right leg, and left leg.

Table II shows the cut-off points for %BF in BJJ athletes. The very-low and low cut-off points are below 11.5%,

while the median values (equivalent to the 50th percentile) comprise values >11.5 % up to 17 %. The high rating comprises >17 % to 24 %, and very high values include >24 %.

Significant differences were found for %BF between competitive levels, with lower values for national and international level athletes when compared to state-level athletes ($p < 0.001$) and a tendency to lower values for international-level athletes when compared to national level athletes ($p = 0.07$). Besides, no significant difference was observed for body mass between the state, national or international level athletes ($p > 0.05$), indicating that the athletes of different levels with equivalent body mass showed a significant difference of %BF among them. The comparisons between graduations (belt) were not made since the international level athletes remain during some years in the same graduation, once the central aspect is referred to compete in high-level, independent of the graduation. Figure 1 shows the comparisons between the different competitive levels of BJJ athletes for %BF.

Table I. Main characteristics of the Brazilian jiu-jitsu athletes.

Variables	Mean	SD	Minimum	Maximum	CI 95%
TBW (L)	48.9	6.5	29.2	62.4	47.3-50.6
LM (kg)	63.3	8.7	37.4	83.6	61.1-65.4
FFM (kg)	66.7	8.9	39.7	85.3	64.4-68.8
BM (kg)	82.1	12.7	55.1	125.2	78.9-85.2
FM (kg)	16.0	8.9	5.2	44.1	13.8-18.2
BMC (kg)	3.7	0.6	2.3	4.8	3.6-3.8
SMM (kg)	37.9	5.4	21.6	49.4	36.5-39.2
BMI (kg/m^2)	26.3	3.3	19.3	37.4	25.5-27.2
%BF (%)	17.3	6.8	7.0	30.3	15.6-19.1
BMR (kcal)	1811.4	193.4	1228.0	2213.0	1763.0-1859.7
RA (kg)	4.0	0.7	2.0	5.6	3.9-4.2
LA (kg)	4.0	0.7	2.0	5.5	3.8-4.1
Trunk (kg)	30.1	3.9	18.3	38.6	29.2-31.1
RL (kg)	9.9	0.20	4.1	12.4	9.5-10.3
LL (kg)	9.8	0.20	4.0	12.4	9.4-10.2

Note: SD = standard deviation; CI 95 % = 95 % confidence interval; TBW = total body water; LM = lean mass; FFM = fat-free mass; BM = body mass; FM = body fat mass; BMC = bone mineral content; SMM = musculoskeletal mass; BMI = body mass index; %BF = percentage of body fat; BMR = basal metabolic rate; RA = right arm; LA = left arm; RL = right leg; LL = left leg.

Table II. Cut-off points for body fat percentage in Brazilian jiu-jitsu athletes.

Percentile	Body fat percentage	Classification
p10	$\leq 7.7\%$	Very low
p25	$> 7.7 - 11.5\%$	Low
p50	$\geq 11.6 - 17.0\%$	Medium
p75	$\geq 17.1 - 24.0\%$	High
p90	$\geq 24.1\%$	Very high

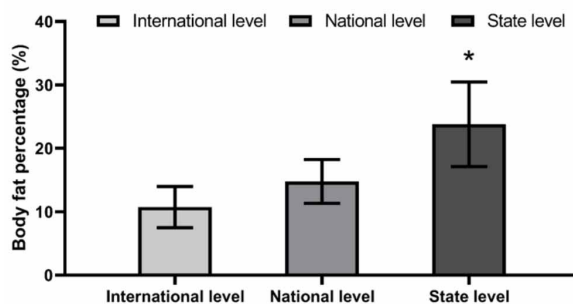


Fig. 1. Body fat percentage among different Brazilian jiu-jitsu athletes at competitive levels. Note: * = a significant difference was observed with higher values for state-level athletes when compared to national and international levels, $p < 0.001$.

DISCUSSION

Based on the incipient studies that compared body composition responses in BJJ athletes, this study's aim could help professionals establish the proposition of cut-off points for the classification of %BF. In addition, this research could promote %BF ratings for assertive nutritional behaviors since previous evidence points to poor nutritional quality among BJJ athletes (Andreato *et al.*, 2016). Athletes from other grappling combat sports, such as judo and wrestling, present a low %BF (Callan *et al.*, 2000; Franchini *et al.*, 2011; Horswill, 1992). In judo, Franchini *et al.* (2011) indicate that high-level athletes present < 10 %BF (between 7-13.7 %), implying that athletes of higher competitive level exhibit lower %BF when compared to athletes of lower competitive level. In wrestling, values between 3-13 % of relative fat during in-season and between 8-16 % off-season were verified (Horswill; Callan *et al.*). In turn, the present study showed ~17.3 %BF (range: 7 % to 30 %), with a higher %BF in athletes from the heaviest categories. Ratamess (2011) also suggest that athletes from lighter categories tend to have a lower %BF than athletes from heavier categories. Thus, it appears that the %BF fluctuates during the sports season, and the monitoring of adiposity is essential for decision-making about what would be the most suitable weight class for an athlete to compete.

In certain sports, the athlete's body composition is directly related to the physical demands of the sport. In this sense, high lean mass and low-fat mass are related to better athletic performance (Suchomel *et al.*, 2016). Low body fat levels contribute to muscular and cardiorespiratory endurance, speed, and agility, while high body fat levels could limit these physical abilities (Durkalec-Michalski *et al.*, 2016; Suchomel *et al.*). When compared to competitive levels, national and international-level athletes presented values significantly lower than state-level athletes. Given this, the results found in the present study are like those reported by Marinho *et al.* who found lower values for %BF in elite vs. non-elite athletes. Therefore, the findings of the present study reinforce the necessity of adiposity control in BJJ athletes. However, sports performance is multifactorial, requiring a technical, tactical, and physical analysis, which should not be limited to %BF.

Body composition is an essential indicator of physical fitness and performance in grappling combat sports since athletes are classified by weight category. In lighter categories, fighters must have a lower %BF and a better strength-to-body mass ratio. On the other hand, the higher weight categories athletes can benefit from high levels of lean mass and reduced fat mass, as the increase in body mass will promote an increase in inertia, making movement, control, and taking down athletes more difficult (Andreato *et al.*, 2017; Franchini *et al.*, 2011).

Studies with grappling combat sports athletes have shown that body fat levels are negatively correlated with aerobic performance (Durkalec-Michalski *et al.*; Balci *et al.*, 2020), anaerobic performance (Ceylan *et al.*, 2018), specific sport performance (Franchini *et al.*, 2007; Arazi *et al.*, 2017; Ceylan *et al.*), and performance on generic tests (Athayde *et al.*).

Finally, a limitation of this study is that the proposed cut-off points were performed via assessment of body composition in the BIA InBody 570® and cannot be transposed to other assessment methods such as skinfold thickness, ultrasonography, hydrostatic weighing, plethysmography, dual-energy X-ray absorptiometry (DXA), and others because there are distinctions between the different assessment methods (Kasper *et al.*, 2021). However, considering that BIA has been disseminated worldwide, it is believed that the proposed values for classification of %BF in BJJ athletes can guide classification propositions for skinfold thickness and even DXA to help professionals involved in sports training and athlete nutrition.

It is considered that the proposition of cut-off points for the classification of the %BF of BJJ athletes can promote choosing the adequate weight category (maintaining, reducing, or increasing body weight category) in which the athlete will compete, in congruence with the relative level of body adiposity. Another significant point is related to physical preparation, that is, to define the weight category.

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RESUMEN: La grasa corporal puede distinguir a los atletas de jiu-jitsu brasileño (BJJ) según el nivel competitivo. Sin embargo, las propuestas de puntos de corte para establecer clasificaciones de porcentaje de grasa corporal para deportistas de deportes de combate y, específicamente, para deportistas de BJJ son aún incipientes en la literatura. En este sentido, el objetivo principal del presente estudio fue establecer una tabla normativa para la clasificación del porcentaje de grasa corporal en atletas de BJJ. Secundariamente,

comparar a los deportistas según el nivel competitivo. Participaron noventa atletas masculinos de BJJ (edad: $29,0 \pm 8,2$ años; tiempo de práctica: $6,0 \pm 2,1$ años; masa corporal: $82,1 \pm 12,7$ kg; estatura: $175,9 \pm 6,5$ cm; masa adiposa: $16,0 \pm 8,9$ kg; contenido mineral óseo: $3,7 \pm 0,6$ kg; masa muscular: $37,9 \pm 5,4$ kg; porcentaje de grasa corporal: $17,3 \pm 6,8$ %; tasa metabólica basal: $1811,4 \pm 193,4$ kcal) de diferentes niveles competitivos: estatal (n= 42), nacional (n= 26) e internacional (n= 22). Se evaluó la composición corporal a través de bioimpedancia tetrapolar. Para establecer la clasificación se utilizaron los percentiles p10, p25, p50, p75 y p90. Como resultado se obtuvo la siguiente clasificación: $<7,7$ % (muy bajo); $\geq 7,7-11,5$ % (bajo); $11,6-17,0$ % (medio); $17,1-24,0$ % (alto) y $\geq 24,1$ % (muy alto). Los atletas de nivel estatal tenían un porcentaje de grasa corporal más alto respecto a los atletas de nivel nacional e internacional (p < 0.05). Los puntos de corte propuestos pueden ser útiles para monitorizar la grasa corporal de los atletas de BJJ.

PALABRAS CLAVE: Artes marciales; Rendimiento deportivo; Deportes de combate; Composición corporal.

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