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ORIGINAL ARTICLE

Body composition, somatotype, and physical fitness of mixed martial arts athletes

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Abstract
Purpose To describe the morphofunctional characteristics of elite mixed martial arts athletes.
Methods Eight male Brazilian athletes (aged: 31 ± 5 years; training experience: 5 ± 1 years; height: 1.77 ± 0.05 m; body mass: 82.1 ± 9.6 kg) with national training experience were subjected to anthropometric evaluation to estimate body composition and somatotype, and maximal strength (1 RM) in squat and bench press, abdominal and upper limb endurance, and lower limb power were determined.
Results Body fat levels of 13.4 ± 5.6 %, lean mass levels of 69.6 ± 4.6 %, and mesomorphic component (6.4 ± 0.8) were observed. Athletes performed 42 ± 14 sit-ups and 37 ± 9 push-ups, and remained for 35 ± 10 s in the flexed-arm hang test. Athletes reached 2.19 ± 0.31 m in the horizontal jump test, and obtained absolute 1-RM values of 80 ± 15 kg and 68.5 ± 6.0 kg and relative values of 1.00 ± 0.2 kg/kg and 0.84 ± 0.10 kg/kg in bench press and squat tests, respectively.
Conclusion Results indicate body fat levels in accordance with other studies, high lean body mass, and a predominantly mesomorphic component. Abdominal and upper limb endurance were classified as excellent, while results of the flexed-arm hang test were similar to previous data. Mixed martial arts athletes' lower limb performance in the horizontal jump was classified as weak. Lower levels of maximal strength were obtained in squat and bench press tests.

Keywords Physical evaluation · Combat sports · High performance

Introduction

Mixed martial arts (MMA) became popular in the 1990s with the creation of the Ultimate Fight Championship (UFC). MMA is a mixture of various combat sports, including striking (such as boxing, kick-boxing, and muay thai) and grappling (such as Brazilian jiu-jitsu, judo, Greco-Roman wrestling, and freestyle wrestling) [1]. The main characteristic of the modality is the intermittency [1, 2]; MMA is a physiologically demanding sport, and it can potentially challenge and tax all of the energy systems [3]. Thus, the endurance strength, maximum strength, power, aerobic, and anaerobic power are important for maintaining the performance during the match. In addition, the technical and tactical aspects are determinant in the combat. In fact, the most successful athletes combine elite level skills with extraordinary strength and conditioning levels [4].

Strength and conditioning guidelines were formally established for grappling and striking sports: wrestling [5, 6], Brazilian jiu-jitsu [7], submission [8], judo [9], and boxing [10]. Moreover, the literature on combat sports reports on various investigations of physical and physiological characteristics of judo [11], wrestling [12],

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Brazilian jiu-jitsu [13], karate [14], taekwondo [15], wushu [16], and MMA [17, 18]. Although there are studies about MMA [1, 17, 18], understanding of functional and morphological characteristics of MMA athletes remains limited. Though success does not depend solely on these variables, the consciousness of these factors, especially in elite athletes, helps to identify patterns required to achieve success [13].

Due to the fact that mixed martial arts athletes are divided into body mass categories, weight loss is an extremely common result. Hence, control of body composition is necessary to define athletes' best weight category without the need of aggressive weight loss processes [19]. In addition, higher levels of body fat are negatively correlated with performances of locomotion, techniques [20, 21], muscular power of lower limbs, and strength endurance [17].

The requirements of muscular force and power have been reported in crucial moments of combat sports. Thus, the evaluation of these variables enables one to estimate athletes' capacity, compare it with other reference groups, and provide feedback on training status [11, 15].

Although MMA is one of the most popular combat sports, a few investigations of morphologic and functional characteristics are available. As a result, MMA athletes' training program remains without any scientific basis and unknown patterns. Therefore, according to aforementioned considerations, this study aims to investigate the morpho-functional profile of elite MMA athletes. The research question of this study was: What level of physical fitness is presented by MMA athletes at national level?

Methods

Subjects

Eight male MMA athletes experienced in national-level competition took part in the study (aged: 31 ± 5 years; training experience: 5 ± 1 years). These athletes were engaged in regular MMA training 5 days per week and were in the preparatory period. Five athletes had the Brazilian jiu-jitsu as their modality of origin, with experience of more than 5 years (one purple-belt, two brown-belts, and two black-belts) before to start MMA specific training. Three athletes had the muay-thai as their modality of origin, with experience of more than 2 years before to start MMA specific training. Before participation, subjects were informed about the nature and risks involved in the experiment, as well as procedures for the tests. All athletes signed a statement of informed consent.

Experimental design

The athletes were subjected to anthropometric evaluation to estimate body composition and somatotype, and maximal strength (1 RM) in squat and bench press, abdominal and upper limb endurance, and lower limb power were determined.

Anthropometric measurements

Athletes underwent measurements of body mass (kg) and height (cm) on a scale with a stadiometer attached to a Welmy (precision to 0.5 cm and 100 g, respectively). Body mass index (BMI) was obtained using body mass/stature^2 quotient (kg/m^2). Skinfold thickness was measured three times on the right side of the body, in rotation system, using a Cescorf® (Brazil) scientific caliper from triceps, abdomen, subscapular, and medial calf sites. The median value was considered. Measurements were performed by a single evaluator who had experience in conducting these measurements. From skinfold thickness, body density was determined using Lohman's protocol [22]. After determining body density, the Siri [23] equation was used to estimate body fat percentage. Mass muscle was estimated by the equation proposed by Lee et al. [24].

To determine somatotypes, ten required measurements were used in accordance with Carter and Heath [25]: body mass, height, four skinfold measurements (triceps, subscapular, suprailiac, and medial calf), two girths measurements (arm tensed and calf), and biepicondylar breadths of humerus and femur.

Physical fitness tests

Muscular endurance was measured with sit-up and push-up tests, following procedures proposed by Pollock and Wilmore [26]. In the horizontal jump test [27], three attempts were performed for each athlete, and the longest jump was considered for analysis. The upper body isometric strength endurance was evaluated using the flexed-arm hang test [27], in which the athlete remained suspended with the chin above the bar for as long as possible. Time was recorded in seconds.

The maximal strength was measured through bench press and squat tests of one maximum repetition (1 RM). All subjects were familiar with the tests' performance. Each athlete carried out at least three and at most five trials, with 3- to 5-min intervals in between, following recommendations made by Brown and Weir [28]. The score was presented for both absolute and relative strength.

Statistical analysis

Data normality was assessed by the Shapiro–Wilk test. Pearson's correlation coefficient was adopted to calculate correlations between variables, with the significance level set at $P < 0.05$ in all cases. Descriptive statistics were used to characterize the sample, and results were presented as mean, standard deviation (SD), and confidence interval of 95 % (CI 95 %). The coefficient of variation (ratio of the standard deviation to the mean) was calculated. Statistical analysis was carried out using the statistical software Sigma-Plot 12.0.

Results

Morphological characteristics of mixed martial arts athletes are presented in Table 1.

The coefficients of variation were 41.8, 6.6, and 12.5 % for body fat, muscle mass, and mesomorphic component, respectively.

The applied test results are shown in Table 2. Athletes presented a high level of physical fitness, especially in strength endurance.

The coefficients of variation were 33.3, 24.3, 14.2, and 27.3 % for sit-ups, push-ups, long jump, and flexed-arm hang tests, respectively. For absolute strength, the coefficients of variation were 18.8 and 8.8 %, and for relative strength, they were 20.0 and 11.9 % in bench press and squat, respectively.

The main correlations are shown in (Fig. 1). The ectomorphic component was positively correlated with lower body relative maximal strength measured by 1 RM in squat (A) ($r = 0.80$; $P = 0.016$), and upper body with relative maximal strength measured by 1 RM in bench press (B) ($r = 0.70$; $P = 0.050$), and was negatively correlated with body fat (C) ($r = -0.84$; $P = 0.007$). An endomorphic component was negatively correlated with upper body isometric strength endurance measured by flexed-arm hang test (D) ($r = -0.75$; $P = 0.029$).

Table 1 Morphological characteristics of mixed martial arts athletes ($n = 8$)

Variable	Mean	SD	CI 95 %
Body mass (kg)	82.1	9.6	76.1–88.1
Height (m)	1.77	0.05	1.74–1.80
BMI (kg/m^2)	26.0	3.3	23.9–28.1
Body fat (kg)	11.8	6.2	7.9–15.7
Body fat (%)	13.4	5.6	9.9–16.9
MM (%)	69.6	4.6	66.7–72.5
Somatotype			
Endomorphy	2.9	1.5	1.9–3.8
Mesomorphy	6.4	0.8	5.5–6.5
Ectomorphy	1.9	1.3	1.1–2.8

SD standard deviation, *CI 95 %* confidence interval of 95 %, *BMI* body mass index, *MM* muscle mass

Table 2 Physical fitness of mixed martial arts athletes ($n = 8$)

Variable	Mean	SD	CI 95 %
Sit-ups (rep)	42	14	33.4–50.8
Push-ups (rep)	37	9	31.6–43.0
Long jump (m)	2.19	0.31	2.05–2.33
Flexed arm hang (s)	35	10	29–41
1 RM—absolute (kg)			
Bench-press (kg)	80	15	71–91
Squat (kg)	69	6	65–72
1 RM—relative (kg/kg)			
Bench-press (kg/kg)	1.0	0.2	0.9–1.1
Squat (kg/kg)	0.8	0.1	0.8–0.9

SD standard deviation, *CI 95 %* confidence interval of 95 %

Discussion

Results indicated medium body fat level [17, 18], high muscle mass percentage, and predominant mesomorphic component [25]. Athletes' performance in sit-ups and push-ups tests was classified as excellent [29]. Maximal strength measured by 1 RM in squat and bench press tests [30], and muscular power of lower limbs estimated by horizontal jump was low [31]. Despite the non-existent benchmarks for the flexed-arm hang test, results were similar to other studies involving MMA athletes [17].

Athletes of combat sports are usually separated into weight classes, so control and optimized body composition can reflect in one's competitive advantage. Many studies have negatively associated body fat with performance [15, 20, 21]. However, little is known about the morphological characteristics of MMA athletes, and samples taken by those who have investigated them possess large variability, encompassing amateurs to national-level athletes [17, 18, 32–34]. Moreover, there is a large heterogeneity in the model to estimate body composition, in the use of predictive equations and regarding the period of training which athletes are in [35]. Despite limitations, Table 3 shows the studies that have evaluated body composition in different combat sports.

Data from athletes of this study show body composition values at around 12 % body fat, which is similar to other values involving MMA athletes [17, 18, 32, 33], junior boxers [42], the Brazilian national judo team [20], national

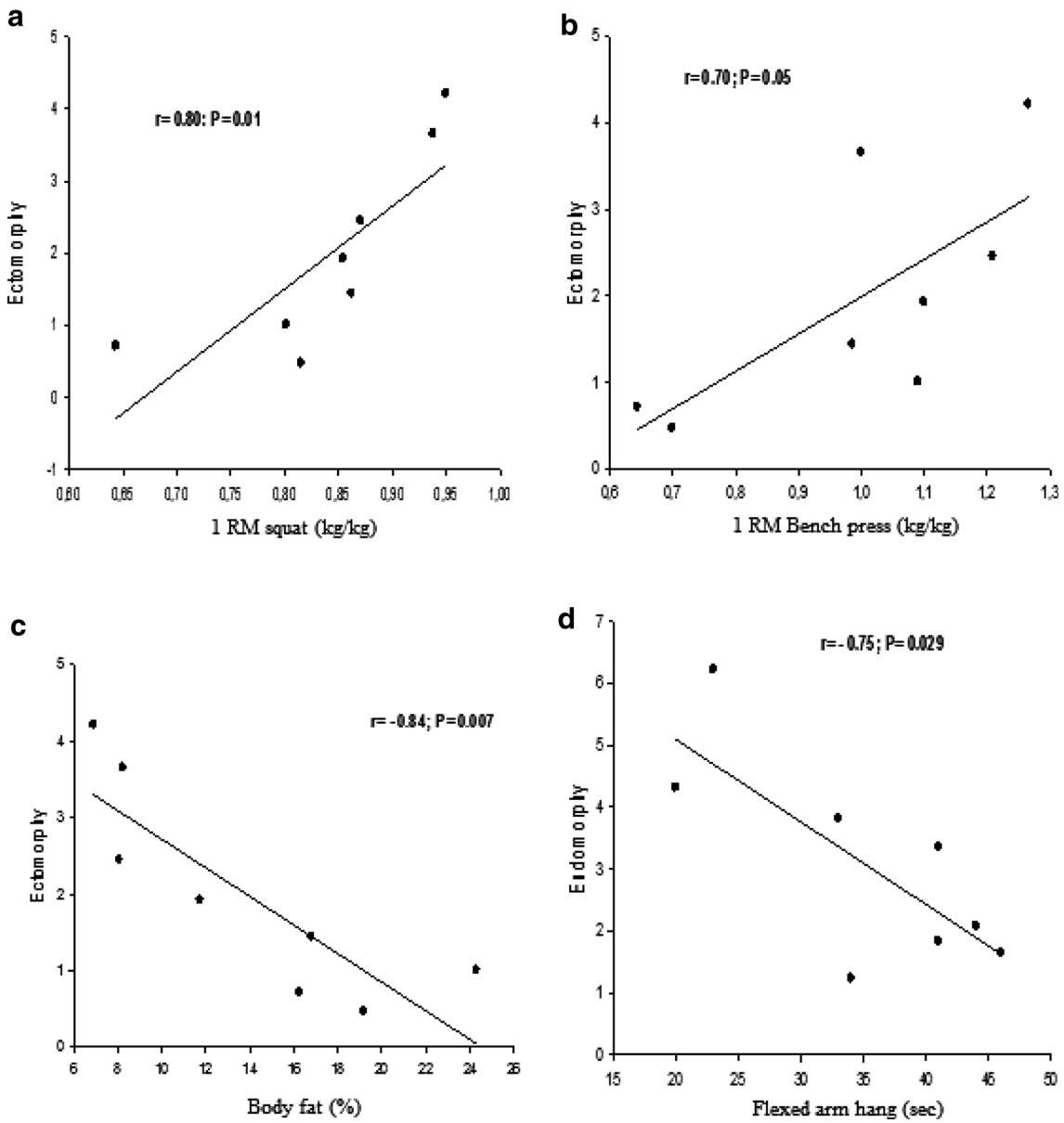

Fig. 1 Main correlations between **a** ectomorphy and 1-RM squat relative, **b** ectomorphy and 1-RM bench press relative, **c** ectomorphy and body fat, and **d** endomorphy and flexed-arm hang in mixed martial arts athletes

and international judokas [38], and heavyweight ju jitsu fighters [40]. However, results from this study are higher than those reported in athletes at a regional MMA level [36], Brazilian jiu-jitsu [35], wu-shu [16], the Brazilian national judo backup team [20], karate [39], lightweight elite ju jitsu athletes [40], and wrestlers [41]. Body fat percentage superior to that found in this study was found in senior Indian boxers [42], brown-belts and black-belts Brazilian jiu-jitsu athletes [37], and in MMA athletes of regional level [34].

Though medium levels of body fat were registered, BMI was classified as overweight [43]. Indeed, this measurement mark should not be applied to athletes, as it is incapable of differentiating the various tissues that make up the human body [35]. Thus, results in Table 3 point out the necessity of body composition control, mainly to guide athletes to maintain body mass near their desirable weight class and avoid rapid weight loss processes.

Another measure to describe the morphological profile is somatotype. Carter and Heath [25] suggested that somatotype and sports success are positively correlated. Furthermore, in combat sports of domain, the mesomorphic component has been described as the most relevant to performance [11, 12].

Table 3 Body composition of athletes from grappling and striking combat sports

Author(s)	Sport	Athletes	*n*	Age (years)	Body mass (kg)	Height (m)	Body fat (%)
Del Vecchio; Ferreira [36]	MMA	Regional	8	28 ± 5	76.1 ± 10.3	1.70 ± 0.06	9.5 ± 4.1
Shick et al. [18]	MMA	Amateur	11	26 ± 6	77.4 ± 11.4	1.74 ± 0.05	11.7 ± 4.0
Gochioco et al. [32]	MMA	NR	11	26 ± 6	77.5 ± 11.5	1.75 ± 0.05	11.8 ± 4.1
Marinho et al. [17]	MMA	Nível nacional	13	30 ± 4	82.1 ± 10.9	1.76 ± 0.05	11.9 ± 5.1
Siqueido [33]	MMA	Competitors	11	27 ± 5	80.3 ± 7.1	1.77 ± 0.07	12.3 ± 5.8
Oliveira et al. [34]	MMA	Regional	18	27 ± 5	78.3 ± 6.9	1.72 ± 0.05	15.0 ± 7.3
Andreato et al. [35]	Brazilian jiu-jitsu	Elite	11	26 ± 3	83.1 ± 8.7	1.80 ± 0.07	10.3 ± 2.6
Andreato et al. [37]	Brazilian jiu-jitsu	Brazilian jiu-jitsu	10	28 ± 4	81.8 ± 7.4	1.76 ± 0.07	13.0 ± 4.8
Artioli et al. [16]	Kung fu	Brazilian team	10	26 ± 4	76.9 ± 11.3	1.78 ± 0.07	9.5 ± 6.3
Franchini et al. [20]	Judo	Brazilian team	7	26 ± 4	90.6 ± 23.8	1.76 ± 0.09	11.4 ± 8.4
		Reserves of Brazilian team	15	26 ± 5	86.5 ± 16.3	1.76 ± 0.08	10.1 ± 5.7
Branco et al. [38]	Judo	National-international level	10	26 ± 2	75.6 ± 14.9	1.75 ± 0.07	11.5 ± 7.8
Milanez et al. [39]	Karate	International level	4	24 ± 7	64.5 ± 18	1.70 ± 0.11	7.4 ± 5.6
Sterkowicz- Przybycień [40]	Ju-jitsu	Super-elite (heavy)	6	26 ± 1	91.4 ± 10.5	1.82 ± 0.06	11.1 ± 2.1
		Super-elite (light)	6	23 ± 4	70.4 ± 4.1	1.72 ± 0.05	10.1 ± 1.9
Barbas et al. [41]	Wrestling	Elite Greek wrestlers	12	22 ± 1	72.1 ± 3.6	1.74 ± 0.03	7.6 ± 0.9
Khanna; Manna [42]	Boxing	Indian junior boxers	30	18 ± 3	53.6 ± 4.1	1.74 ± 0.06	12.2 ± 1.1
		Indian senior boxers	30	22 ± 3	76.7 ± 10.9	1.79 ± 0.08	16.4 ± 3.8

MMA mixed martial arts, *BMI* body mass index, *NR* not reported

Table 4 Somatotype of athletes from grappling and striking combat sports

Author(s)	Sport	Athletes	*n*	Age (years)	Body mass (kg)	Somatotype		
						EN	ME	EC
Medeiros et al. [44]	MMA	Professional	15	25 ± 4	79.1 ± 8.1	2.7 ± 1.0	6.0 ± 0.8	1.7 ± 0.7
Andreato et al. [35]	Brazilian jiu-jitsu	Elite	11	26 ± 3	83.1 ± 8.7	3.0 ± 0.8	5.5 ± 1.0	1.7 ± 0.6
Del Vecchio et al. [45]	Brazilian jiu-jitsu	National level	7	25 ± 3	78.9 ± 12.2	3.2 ± 1.6	7.9 ± 1.4	1.6 ± 0.6
Claessens et al. [46]	Judo	Elite						
		<71 kg	18	25 ± 4	65.7 ± 4.3	2.3 ± 0.4	5.6 ± 0.5	1.9 ± 0.4
		71–86 kg	9	25 ± 5	81.2 ± 3.7	3.0 ± 0.5	6.0 ± 0.7	1.7 ± 0.7
		>86 kg	11	26 ± 4	108.3 ± 15.1	4.1 ± 0.9	6.2 ± 0.6	1.3 ± 0.4
Farmosi et al. [47]	Judo	Hungarians						
		<71 kg	7	22 ± 4	66.7 ± 3.7	2.5 ± 0.5	6.6 ± 1.3	1.8 ± 1.0
		>71 kg	11	21 ± 2	90.5 ± 18.4	4.3 ± 2.1	7.2 ± 1.6	1.4 ± 0.7
Chan et al. [48]	Taekwondo	Practitioners	10	24 ± 4	71.6 ± 9.0	4.2 ± 1.1	4.7 ± 1.0	2.9 ± 1.0
Sterkowicz-Przybycień [49]	Karate	Polish team						
		International level	14	27 ± 7	86.1 ± 8.2	3.7 ± 1.1	5.8 ± 0.8	1.3 ± 0.6
		National level	16	24 ± 5	81.4 ± 11.9	3.5 ± 1.1	5.0 ± 0.9	2.0 ± 0.6
Khanna; Manna [42]	Boxing	Indian junior boxers	30	18 ± 3	53.6 ± 4.1	1.8 ± 0.5	3.2 ± 0.6	4.0 ± 0.8
		Indian senior boxers	30	22 ± 3	76.7 ± 10.9	2.3 ± 0.6	4.9 ± 0.7	2.3 ± 0.8

EN endomorphy, *ME* mesomorphy, *EC* ectomorphy, *NR* not reported

Table 4 shows somatotype values of different combat sports athletes.

Subjects from this study presented a predominant morphological component, and this is being the most observed results in MMA athletes [44] as well as Brazilian jiu-jitsu [35, 45], judo [46, 47], seniors boxers [42], karate [49], and taekwondo practitioners [48]. However, karate and taekwondo athletes also presented relevant levels of ectomorphic component. Likewise, this was the predominant morphological component for junior boxers [42]. Therefore, muscle mass development is clearly an important component for mixed martial arts athletes and for most of the combat sports.

Strength endurance is another important physical capacity in MMA, especially in combats, which are structured in rounds of 3 to 5 min, with a 1-min rest in between. Table 5 shows the results of strength endurance from different studies in combat sports.

Results of the sit-ups tests classified MMA athletes' performance as excellent [29]. These results were similar to previous data observed in national-level MMA [17] and higher than elite cadet judo athletes [50]. However, results were lower than those reported in studies involving judo athletes from an adult Canadian team [51], the Brazilian university team [52], elite Croatians [53], elite wrestlers [54], and Brazilian jiu-jitsu sportsmen [13].

Muscular upper limbs resistance results were classified as excellent [29]. Subjects' performance in this study was similar to national MMA athletes [17], elite Brazilian jiu-jitsu fighters [13], elite cadets [50], and juniors' judo athletes [53]. Nevertheless, other studies with Iranian wrestlers [54], the Canadian adult judo team [51], and the Brazilian university judo team [53] registered superior values to those obtained from MMA athletes. Furthermore, the flexed-arm hang test was applied to assess upper limb strength and endurance. Performance measured was similar to that observed previously in national MMA athletes (34 ± 11 s) [17].

Combat requires maximal strength to connect or defend strikes and takedowns. Table 6 shows a compilation of studies that evaluate maximal dynamic strength in squat and bench press in combat sports athletes.

In consideration of scores from a reference table of Japanese judokas, maximal strength performance in squat and bench press tests was classified as very low [30]. Furthermore, maximal absolute values for bench press were similar to MMA competitors [33] in national level [17] or regional level [36] and karate Brazilian team [55]. However, results were lower compared with those obtained for the Brazilian judo team [20].

On the other hand, when absolute values of maximal strength were normalized by body mass, data from this study were similar to MMA athletes at national [17] and regional levels [36], while other athletes retained superior levels, such as the Brazilian national judo team [20] and other MMA athletes [18, 32].

To evaluate lower limb muscle power, a horizontal jump test was applied. Performance in the horizontal jump test was classified as weak [31]. Yet, the results were similar to previously reported data from national-level MMA athletes, who reached 2.19 ± 0.25 m [17].

In summary, MMA athletes from this study have body fat levels in accordance with the average levels from previous studies, a high percentage of muscle mass and a

Table 5 Strength endurance of athletes from grappling and striking combat sports

Test	Author(s)	Sport	Athletes	*N*	Age (years)	Body mass (kg)	Repetitions
Sit-ups	Marinho et al. [17]	MMA	National level	13	30 ± 4	82.1 ± 10.9	43 ± 11
	Vidal-Andreato et al. [13]	Brazilian jiu-jitsu	Elite	11	26 ± 3	83.1 ± 8.7	52 ± 7
	Bratic et al. [50]	Judo	Elite cadet	20	NR	NR	36 ± 4
	Krstulovic et al. [53]	Judo	Croatian junior athletes	40	17 ± 1	76.9 ± 13.2	56 ± 8
	Mirzaei et al. [54]	Wrestling	Iranian elite freestyle	11	20 ± 1	89.9 ± 2.3	61 ± 12
	Taylor; Brassard [51]	Judo	Canadian team	19	22 ± 3	80.2 ± 14.9	48 ± 10
	Franchini et al. [52]	Judo	Brazilian university team	5	NR	NR	49 ± 3
Push-ups	Marinho et al. [17]	MMA	National level	13	30 ± 4	82.1 ± 10.9	41 ± 9
	Vidal-Andreato et al. [13]	Brazilian jiu-jitsu	Elite	11	26 ± 3	83.1 ± 8.7	39 ± 8
	Bratic et al. [50]	Judo	Elite cadet	20	NR	NR	40 ± 8
	Krstulovic et al. [52]	Judo	Croatian junior athletes	40	17 ± 1	76.9 ± 13.2	41 ± 12
	Mirzaei et al. [54]	Wrestling	Iranian elite freestyle	11	20 ± 1	89.9 ± 2.3	65 ± 7
	Taylor; Brassard [51]	Judo	Canadian team	19	22 ± 3	80.2 ± 14.9	72 ± 16
	Franchini et al. [52]	Judo	Brazilian university team	5	NR	NR	45 ± 4

NR not reported

Table 6 One repetition maximal (1 RM) of athletes from grappling and striking combat sports

Test	Author(s)	Modality	Subjects	*n*	Age (years)	Body mass (kg)	1 RM (kg)	1 RM (kg/kg)
Bench-press	Del Vecchio; Ferreira [36]	MMA	Regional level	8	28 ± 5	76.1 ± 10.3	76 ± 11	1.0 ± 0.1
	Gochioco et al. [32]	MMA	NR	11	26 ± 6	77.5 ± 11.5	NR	1.3 ± 0.2
	Marinho et al. [17]	MMA	National level	13	30 ± 4	82.1 ± 10.9	76 ± 23	0.9 ± 2.1
	Siqueido [33]	MMA	Competitors	11	27 ± 5	80.3 ± 7.1	86 ± 18	NR
	Schick et al. [18]	MMA	Amateur	11	26 ± 6	77.4 ± 11.4	NR	1.2 ± 0.1
	Franchini et al. [20]	Judo	Brazilian team	7	26 ± 4	90.6 ± 23.8	110 ± 25	1.2 ± 0.1
			Reserves of Brazilian team	15	26 ± 5	86.5 ± 16.3	110 ± 23	1.3 ± 0.2
	Mirzaei et al. [54]	Wrestling	Elite Iranian freestyle	11	20 ± 1	89.9 ± 2.3	NR	1.4 ± 0.1
	Roschel et al. [55]	Karate	Brazilian team (winners)	NR	28 ± 6	74.3. ± 13.3	76 ± 16	NR
			Brazilian team (defeated)	NR	28 ± 5	71.9 ± 7.8	70 ± 11	NR
Squat	Gochioco et al. [32]	MMA	NR	11	26 ± 6	77.5 ± 11.5	NR	1.5 ± 0.2
	Marinho et al. [17]	MMA	National level	13	30 ± 4	82.1 ± 10.9	73 ± 15	0.9 ± 1.4
	Schick et al. [18]	MMA	Amateur	11	26 ± 6	77.4 ± 11.4	NR	1.4 ± 0.1
	Franchini et al. [20]	Judo	Brazilian team	7	26 ± 4	90.6 ± 23.8	NR	1.4 ± 0.1
			Reserves of Brazilian team	15	26 ± 5	86.5 ± 16.3	NR	1.4 ± 0.1
	Mirzaei et al. [54]	Wrestling	Elite Iranian freestyle	11	20 ± 1	89.9 ± 2. 3	NR	1.6 ± 0.1
	Roschel et al. [55]	Karate	Brazilian team (winners)	NR	28 ± 6	74.3. ± 13.3	113 ± 15	NR
			Brazilian team (defeated)	NR	28 ± 5	71.9 ± 7.8	128 ± 20	NR

NR not reported

predominant mesomorphic component. Muscle endurance strength for upper and lower limbs was classified as excellent, while results from the flexed-arm hang test were in accordance with previously reported data from athletes of the same modality. MMA athletes presented an unsatisfactory performance in maximal strength for squat and bench press tests. The muscle power of lower limbs was labeled as weak.

Finally, the data presented collaborates with knowledge of the morphological profile of MMA athletes, and contributes toward identifying the predominant characteristics of this segment. Besides, results can be used as comparative scores to future researchers and as a useful tool in the talent detection process.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval The research was approved by the Local Ethics Committee and carried out in accordance with the Declaration of Helsinki.

Informed consent All subjects signed a written informed consent form.

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