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Assessment of Body Composition and Physical Conditioning in Professional MMA Fighters: Comparison between Male Categories and Descriptive Analysis of Female Athletes

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Abstract

Mixed martial arts (MMA) incorporate movements from various martial arts, which increases the complexity of physical preparation and the variety of physical qualities. Understanding the body characteristics of high-performance athletes can provide valuable insights into the physical attributes required for success in sports. Thus, the objective of this study was to evaluate the body composition and physical conditioning of professional MMA athletes according to the category practiced (heavyweight - HW and lightweight - LW). Thirteen professional MMA fighters were evaluated, including 10 men and 3 women, who train in the city of Rio de Janeiro, Brazil. They underwent an evaluation protocol for anthropometric measurements (according to ISAK) and physical valences. The results indicated that there were no significant differences in body composition or in the tests measuring isometric strength and cardiorespiratory capacity between the categories analysed. In the flexibility test, the LW group showed greater range compared to the HW group. Additionally, the HW group presented a significant difference in the degree of mesomorphy compared to the LW group (P=0.04). These results suggest that, although there are differences in some anthropometric variables, they do not significantly impact body composition based on the category.

Keywords: Mixed Martial Arts, Body Composition, Physical Conditioning, Somatotyping

Resumen

Las artes marciales mixtas (MMA) incorporan movimientos de varias artes marciales, lo que aumenta la complejidad de la preparación física y la variedad de cualidades físicas. Comprender las características corporales de los atletas de alto rendimiento puede proporcionar información valiosa sobre los atributos físicos necesarios para el éxito en los deportes. Así, el objetivo de este estudio fue evaluar la composición corporal y el acondicionamiento físico de atletas profesionales de MMA según la categoría practicada (peso pesado - HW y peso ligero - LW). Se evaluaron trece luchadores profesionales de MMA, incluidos 10 hombres y 3 mujeres, que entrenan en la ciudad de Río de Janeiro, Brasil. Se sometieron a un protocolo de evaluación para mediciones antropométricas (según ISAK) y valencias físicas. Los resultados indicaron que no hubo diferencias significativas en la composición corporal ni en las pruebas de fuerza isométrica y capacidad cardiorrespiratoria entre las categorías analizadas. En la prueba de flexibilidad, el grupo LW mostró mayor rango en comparación con el grupo HW. Además, el grupo HW presentó una diferencia significativa en el grado de mesomorfia en comparación con el grupo LW (P=0.04). Estos resultados sugieren que, aunque existen diferencias en algunas variables antropométricas, no impactan significativamente la composición corporal según la categoría.

Palabras Clave: Artes marciales mixtas, Composición corporal, Acondicionamiento físico, Somatotipado

Introduction

Among combat sports, the importance of physical qualities can vary depending on the specific motor skills of each discipline. Isometric and dynamic strength are essential physical qualities in judo, wrestling, and jiu-jitsu, while explosive strength is crucial for disciplines like boxing, Muay Thai, and karate (Dantas, 2016). However, mixed martial arts (MMA) incorporate movements from all martial arts, which consequently increases the complexity of physical preparation and the variety of physical qualities. Therefore, to compete at a high level, an athlete must possess competence in various types of martial arts (Holmes, McHale, & Zychaluk, 2023).

MMA, like most combat sports, adopts weight classes based on total body mass to promote matches between competitors with similar body sizes (Franchini et al., 2011). A fight in this discipline typically consists of three rounds (except in title fights and main events), each lasting 5 minutes with a 1-minute break between rounds. Previous studies suggest that MMA involves high-intensity efforts with significant energy contribution via the glycolytic system, resulting in high blood lactate concentrations (Siqueira, Arruda, & Schwingel, 2016). Additionally, in MMA, the total fight time can last around 15-25 minutes, which, in turn, makes the aerobic system an important physical quality that also needs to be developed in the sport. Thus, MMA athletes can exhibit good aerobic capacity, high lactate tolerance, and H+ buffering capacity, helping to maintain high levels of intensity during the fight (Alm & Yu, 2013).

Understanding the body characteristics of high-performance athletes can provide insightful information about the necessary traits for sporting success (Spanias et al., 2019). However, body composition characteristics and physical abilities may vary depending on the weight classes (Franchini et al., 2011; Folhes et al., 2022; Peacock et al., 2022). Therefore, the objective of this study was to evaluate the body composition and physical conditioning of professional MMA athletes according to the category they practice.

Materials and Methods

Thirteen professional mixed martial artists practicing in Rio de Janeiro, Brazil, were evaluated during the physical preparation phase, comprising 10 men and 3 women. Like Folhes et al. (2022), male athletes weighing ≤ 76 kg were categorized as lightweight, while those weighing more than 76 kg were classified as heavyweight, according to the CABMMA unified rules. The procedures performed to obtain the evaluative measurements were conducted by a professional in physical education and nutrition, certified as a level 2 anthropometrist by the International Society for the Advancement of Kinanthropometry (ISAK). The anthropometric measurements followed the guidelines provided by the ISAK protocol, consisting of 43 measurements. The protocols were carried out in a private location. The evaluative protocol consisted of the following tests in chronological order: anthropometric measurements, sit and reach test, handgrip strength, isometric scapular strength, isometric lumbar strength, and submaximal Astrand test.

Anthropometric Assessment

All anthropometric assessments followed the ISAK protocol, conducted in duplicate and, when necessary, in triplicate. For the assessments, volunteers were required to wear swimwear (men – swim trunks; women – bikini), and all measurements were taken by the same evaluator. The anthropometric assessment took place between 4:00 PM and 6:00 PM.

The following equipment was used: a digital scientific skinfold caliper and stadiometer by Avanutri®, an anthropometric tape, 16 cm and 60 cm calipers, and a segmometer by Cescorf®, as well as a mechanical scale by Welmy®.

Body Composition and Somatotype

Body composition was determined using the model of body mass fractionation into five components: adipose mass, muscle mass, bone mass, residual mass, and skinfold mass (Norton et al., 1996; Kerr & Ross, 1988). To estimate body fat percentage, the Martin et al. (1994) and Yuhasz (1974) models were used for men, while the Yuhasz (1974) model alone was used for women. Somatotype was calculated using anthropometric techniques as suggested by Carter and Heath (1990).

Physical Tests

The procedures were conducted in a single day during the athletes' physical preparation phase, excluding those who were sidelined due to injury, those who were a few weeks away from competing, or those who were in a transition phase. The Sit and Reach Test (Wells) was used to assess linear flexibility by measuring the distance between the fingertips and the plantar region. Participants were seated with extended knees and their feet resting on the Wells bench, using a bench from the Sunny® brand. Isometric strength was assessed through maximum effort tests using dynamometers. Handgrip strength was measured with an Instrumen® dynamometer, involving finger flexion. Scapular strength was evaluated using a CROW® dynamometer, through isometric scapular adduction. Finally, lumbar strength was also measured with a CROW® dynamometer, using isometric trunk extension performed with semi-flexed knees. Aerobic endurance was measured using the submaximal test by Åstrand and Ryhming (1954), following their guidelines. The test was conducted using a Monark pendulum cycle ergometer with mechanical braking, with resistance expressed in kiloponds (Kp). Participants' heart rates were monitored with a Polar device that utilizes a chest strap for accurate measurements.

Statistical Analysis

Statistical analysis was performed using GraphPad Prism software version 8.0 (La Jolla, USA). The assumption of normality of the data was assessed using the Shapiro-Wilk test. Normality determination guided the use of parametric (Student's t-test) or non-parametric (Wilcoxon) comparisons. Descriptive data from the tests are presented as mean ± standard deviation) for sample characterization. Differences were considered significant when the p-value was less than 0.05.

Results

Table 1. Anthropometric Variables of MMA Athletes.

Anthropometric Variables	All mens		Lightweight		Heavyweight		*p*	Woman	
	Mean ± SD	Z-score	Mean ± SD	Z-score	Mean ± SD	Z-score		Mean ± SD	Z-score
Basic measurements									
Body mass (kg)	86,2 ± 9,6	0,93	78,6 ± 4,0	0,64	93,8± 6,7	1,17	***0,002***	61,5 ± 5,6	0,45
Stretch stature (cm)	180,2 ± 6,4	-	176,8 ± 4,7	-	183,7 ± 5,9	-	0,087	164,2 ± 5,1	-
Sitting height (cm)	92,1 ± 2,7	-0,65	90,5 ± 2,1	-0,62	93,6 ± 2,3	-0,71	0,068	89 ± 2,6	0,52
Arm span (cm)	190,8 ± 8,5	1,06	188,8 ± 5,0	1,26	192,9 ± 11	0,86	0,475	167,1 ± 7,4	0,11
Lengths (cm)									
Acromiale-radiale	36,4 ± 1,5	1,07	36,1 ± 1,0	1,25	36,8 ± 1,9	0,89	0,558	32,0 ± 1,6	0,36
Radiale-stylion radiale	26,9 ± 1,5	0,6	26,6 ± 1,6	0,79	27,1 ± 1,3	0,41	0,641	22,4 ± 0,9	-0,99
Midstylion-dactylion	20,9 ± 1,3	1,03	20,6 ± 0,9	1,15	21,2 ± 1,5	0,91	0,499	18,5 ± 1,67	0,38
Iliospinale height	103,1 ± 5,0	0,68	100,4 ± 3,7	0,55	105,7 ± 4,6	0,81	0,095	90,8 ± 5,7	0
Trochanterion height	93,3 ± 5,8	0,4	89,8 ± 3,5	0,02	96,8 ± 5,4	0,76	***0,049***	82,3 ± 4,7	-0,26
Trochanterion-tibiale laterale	46,5 ± 4,0	1,01	45,8 ± 3,4	1,11	47,1 ± 4,4	0,9	0,062	41,4 ± 4,4	0,62
Tibiale laterale height	47,4 ± 4,3	-0,04	46,0 ± 0,8	-0,2	48,7 ± 6,1	0,11	0,36	39,7 ± 0,9	-1,42
Tibiale mediale-sphyrion tibiale	39,5 ± 2,8	0,26	38,3 ± 2,1	0,02	40,8 ± 2,8	0,47	0,164	33,6 ± 1,8	-0,92
Breadths (cm)									
Biacromial	42,0 ± 2,1	0,83	41,6 ± 1,2	1,03	42,4 ± 2,7	0,63	0,573	37,4 ± 1,2	0,38
Anterior-posterior abdominal	20,2 ± 1,9	-	19,0 ± 1,2		21,5 ± 1,5	-	***0,02***	16,4 ± 0,6	-
Biiliocristal	28,5 ± 2,3	-1,09	27,0 ± 1,3	-1,61	30,0 ± 2,1	-0,6	***0,031***	27,0 ± 1,1	-0,48

Foot	28,0 ± 4,6	0,78	28,5 ± 6,0	1,7	27,4 ± 1,4	-0,12	0,058	23,9 ± 2,0	-0,66
Transverse chest	29,6 ± 2,1	0	28,4 ± 1,4	-0,34	30,7 ± 2,2	0,31	0,085	23,2 ± 3,0	-2,24
Anterior-posterior chest depth	18,5 ± 1,1	-0,03	18,4 ± 0,6	0,16	18,6 ± 1,5	-0,22	0,801	14,9 ± 2,3	-1,48
Humerus (biepicondylar)	7,3 ± 0,5	1,24	6,9 ± 0,3	0,57	7,7 ± 0,4	1,87	***0,012***	6,5 ± 0,4	0,82
Wrist (bistiloid)	5,4 ± 0,5	-0,23	5,5 ± 0,5	0,3	5,4 ± 0,5	-0,74	0,759	5,1 ± 0,2	0,27
Femur (biepicondylar)	9,9 ± 0,5	-0,39	9,5 ± 0,2	-0,74	10,2 ± 0,3	-0,09	***0,004***	8,8 ± 0,6	-0,83
Ankle (bimaleolar)	7,8 ± 0,5	1,8	7,4 ± 0,2	1,34	8,1 ± 0,4	2,24	***0,015***	6,7 ± 0,5	0,73
Girths (cm)									
Head	57,7 ± 1,5	-1,05	57,6 ± 1,6	-0,42	57,8 ± 1,3	-1,69	0,801	54,4 ± 0,5	0,26
Neck	40,97 ± 2,85	2,19	39,0 ± 2,0	1,53	42,9 ± 1,9	2,8	***0,019***	33,3 ± 0,7	-0,23
Arm relaxed	34,3 ± 2,1	2,37	32,7 ± 1,34	1,95	36,0 ± 1,0	2,77	***0,003***	30,1 ± 3,8	1,87
Arm flexed and tensed	37,4 ± 2,3	2,51	35,6 ± 1,4	2,06	39,2 ± 1,0	2,94	***0,01***	31,7 ± 2,8	1,46
Forearm	30,2 ± 1,3	2,38	29,2 ± 0,9	2,14	31,1 ± 0,8	2,59	***0,012***	25,5 ± 1,5	0,92
Wrist	17,2 ± 0,7	-0,16	16,8 ± 0,5	-0,18	17,3 ± 0,6	-0,15	0,124	15,2 ± 0,3	-0,83
Chest	106,7 ± 4,2	2,5	103,9 ± 2,1	2,34	109,6 ± 3,6	2,64	***0,018***	89,0 ± 4,7	0,85
Waist (minimum)	84,8 ± 4,9	1,84	80,8 ± 1,4	1,32	88,8 ± 3,5	2,33	***0,001***	72,4 ± 6,0	0,7
Hips	97,46 ± 4,0	-0,47	96,4 ± 3,4	-0,34	98,5 ± 4,3	-0,61	0,44	93,2 ± 5,5	0,16
Thigh 1 cm gluteal	60,3 ± 3,7	0,27	57,5 ± 2,0	-0,12	63,1 ± 2,4	0,64	***0,005***	56,6 ± 4,4	0,68
Thigh middle	56,9 ± 4,0	0,13	53,7 ± 1,9	-0,33	60,1 ± 2,4	0,56	***0,002***	53,1 ± 6,0	0,4
Calf	38,0 ± 1,8	1,09	37,0 ± 0,9	0,17	38,9 ± 2,0	0,35	0,094	34,1 ± 2,6	0,03
Ankle	25,2 ± 2,2	1,58	23,9 ± 1,3	0,99	26,5 ± 2,2	2,14	0,062	23,5 ± 2,2	2,01
Skinfolds (mm)									
Triceps	8,8 ± 2,1	-1,59	8,8 ± 1,2	-1,54	8,7 ± 2,9	-1,65	0,062	12,9 ± 5,5	-0,46
Subescapular	9,8 ± 2,5	-1,57	8,9 ± 1,4	-1,7	10,7 ± 3,1	-1,44	0,285	12,4 ± 6,4	-0,86
Biceps	3,6 ± 0,6	-2,29	3,5 ± 0,7	-2,3	3,7 ± 0,3	-2,27	0,605	4,7 ± 1,5	-1,55
Iliac crest	14,7 ± 6,1	-1,25	12,0 ± 3,6	-1,59	17,4 ± 7,1	-0,92	0,174	15,1 ± 5,4	-0,99
Supraspinale	8,4 ± 3,1	-1,67	6,8 ± 1,7	-1,97	9,9 ± 3,4	-1,39	0,118	8,7 ± 3,1	-1,42
Abdominal	11,8 ± 5,0	-1,83	8,8 ± 2,4	-2,17	14,7 ± 5,2	-1,51	0,054	12,9 ± 5,6	-1,55
Thigh	11,8 ± 3,7	-1,9	12,1 ± 2,8	-1,84	11,6 ± 4,6	-1,95	0,843	19,4 ± 5,4	-0,83
Calf	7,5 ± 1,9	-1,92	8,3 ± 2,2	-1,71	6,6 ± 0,6	-2,12	0,167	10,5 ± 4,9	-1,1

p= statistical significance between categories; SD= Standard deviation; Z-score= Phantom Z-score as proposed by Ross and Wison (1974)

Table 2. Body composition of men (lightweight and heavyweight) and woman MMA fighters.

Body Composition	**Mens**							**All womens (*n*= 3)**	
	All mens (*n*= 10)		**Lightweight (*n*= 5)**		**Heavyweight (*n*= 5)**		*p*		
	Mean	SD	Mean	SD	Mean	SD		Mean	SD
Muscle mass (%)	52,54	2,06	52,19	1,84	52,88	2,42	0,62	46,18	1,1
Adipose mass (%)	20,7	2,13	20,80	2,02	20,60	2,47	0,62	27,83	2,12
Residual mass (%)	11,11	0,43	11,14	0,32	11,09	0,56	0,85	9,00	0,31
Bone mass (%)	10,76	0,8	10,77	0,78	10,75	0,92	0,96	11,27	0,98
Skin mass (%)	4,89	0,27	5,10	0,20	4,68	0,12	***0,00***	5,72	0,69
Body fat (%) [1]	12,13	1,85	12,20	1,75	12,06	2,15	0,91	-	-
Body fat (%)[2]	8,68	1,29	8,24	1,06	9,12	1,47	0,31	15,47	4,54
∑6 Skinfolds (mm)	57,99	12,35	53,80	10,28	62,18	13,91	0,31	76,8	29,23
Bone-muscle index (kg)	4,91	0,49	4,86	0,42	4,96	0,59	0,77	4,12	0,35
Adipose-Muscle (kg)	0,40	0,06	0,40	0,05	0,39	0,07	0,76	0,60	0,06
BMI (kg/m^2)	26,48	1,79	25,17	1,50	27,80	0,77	***0,00***	22,9	3,25
Endomorphy	2,54	0,55	2,34	0,52	2,74	0,55	0,27	3,57	1,63
Mesomorphy	5,95	0,96	5,36	1,06	6,54	0,22	***0,04***	4,87	1,91
Ectomorphy	1,43	0,58	1,74	0,64	1,11	0,33	0,09	2,03	1,56

∑= sum; *n*= athletes; *p*= statistical significance between categories; SD= Standard deviation; [1] = Martin et al., 1994; [2] = Yahasz et al., 1994

Table 3. Comparison between physical values the preparatory and pre-competitive period.

Variables	Mens							All womens (*n*= 3)	
	All mens (*n*= 10)		Lightweight (*n*= 5)		Heavyweight (*n*= 5)		*p*		
	Mean	SD	Mean	SD	Mean	SD		Mean	SD
Sit And Reach Test (cm)	33,44	12,87	39,04	5,23	26,8	9,55	0,03	38,17	4,31
Isometric lumbar Strength (kgf)	181,72	19,54	170,2	19,43	193,2	12,23	0,05	105	12,77
Isometric lumbar Strength Rel. (kgf. BW^{-1})	2,12	0,2	2,16	0,24	2,1	0,08	0,61	1,71	0,11
Isometric Scapular Strength (kgf)	44,42	6,5	43,5	7,85	43,96	5,76	0,92	28,47	8,59
Isometric Scapular Strength Rel. (kgf. BW^{-1})	0,51	0,1	0,56	0,12	0,49	0,08	0,34	0,46	0,11
Handgrip Isometric strengh (kgf)	55,28	5,87	53,54	5,08	55,96	6,75	0,53	40,1	4,90
Handgrip Isometric strengh (kgf. BW^{-1})	0,67	0,07	0,7	0,07	0,61	0,06	0,07	0,66	0,11
VO^{2}máx Rel. (ml.kg.min-^{1})	45,3	9,2	46,96	10,79	44,44	7,21	0,67	54,32	7,07

BW= Body Weight; VO^{2}máx= Maximum oxygen consumption; Rel.= Relative; *n*= athletes; *p*= statistical significance.

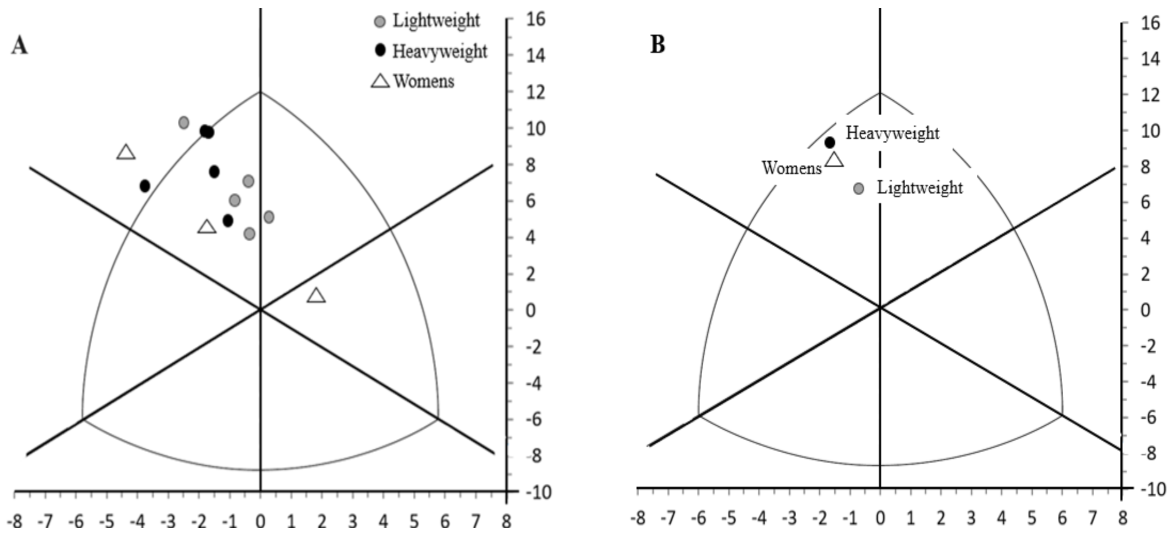

Figure 1. A.=Distribution of athletes on the somatocarta. B = Somatopoint of the average somatotype for each category and the average dispersion index of the somatotype

Discussion

Body composition can be assessed by various methods, such as DEXA, ultrasound, hydrostatic weighing bioimpedance, 3D scanning, and skinfold measurements (Kasper et al., 2021). In MMA, the most used method is skinfold measurement. The two-component model for body mass fractionation is typically adopted for body composition assessment in these athletes (Spanias et al., 2019).

Our results for body fat percentage in male MMA athletes are consistent with those reported for amateur levels (9.5 – 13.4% by Del Vecchio & Ferreira, 2013, and Marinho et al., 2016, respectively), professional, and elite levels (an average of 12.25% by Alm, 2013).

When comparing male athletes based on weight class, our results demonstrated no significant differences in body composition between Professional Lightweight and Heavyweight athletes. Muñoz, Franco, and Martínez (2024) found that body fat percentage values were very similar across the lightweight categories, with values of 9.6% for lightweight, 7.7% for flyweight, and 9.8% for featherweight. In contrast to the findings of Verli et al. (2023) in jiu-jitsu athletes, we did not identify significant differences in skinfold thicknesses at the triceps, subscapular, abdominal, and suprailiac sites between light and heavy categories in the present study. The same pattern was observed in the sum of skinfolds. However, consistent with Verli et al. (2023), heavy-category athletes demonstrated larger body circumferences and greater bone diameters, especially in the biepicondylar humerus and femur, compared to light-category athletes. These data suggest that body composition between weight categories in MMA does not exhibit differences as pronounced as those observed in jiu-jitsu athletes (Table 2).

Body composition is especially important since previous studies have demonstrated a negative correlation between physical capacities requiring body displacement and body fat percentage in MMA (Bernardi et al., 2019). As a result, the UFC PI (2021) recommends that male athletes maintain a body fat percentage between 7-14% during the mid-fight camp phase, while the recommendation for women is between 14-24%. The body fat percentages of female MMA athletes in this study were like those described for an elite athlete by Soares (2018) (18.9%, assessed by anthropometry using the Petroski equation) and by Muñoz, Franco, and Martínez (2024) (12.2 ± 3.67%, assessed by Yahasz anthropometry) (Table 1, Table 2).

Somatotype is a method of quantifying and classifying the shape and composition of the human body at the time it is studied, therefore, although genetics plays an important role, it is a phenotypic variable (Esparza-Ros & Vaquero-Cristóbal, 2023). In this regard, athletes of both sexes and regardless of weight class exhibited a mesomorphic endomorph classification. However, the mesomorphy value for male Lightweight athletes was significantly lower than that of the Heavyweight category. The values found by Muñoz, Franco, and Martínez (2024) for the categories grouped as lightweight in this study were 2.50, 5.09, and 1.93 for endomorphy, mesomorphy, and ectomorphy, respectively. Thus, as already pointed out by the authors, Colombian and Brazilian male athletes share many physical characteristics. On the other hand, the somatotype of the female athletes presented by Muñoz, Franco, and Martínez (2024) showed a different classification than that found in this study (Figure 1). In the present study, mesomorphy was predominant, while in the previously cited study, endomorphy was more common.

In the sit-and-reach test, we observed significant differences in the distance achieved between heavy and light-category athletes. This significant difference may be partially explained by the greater trochanteric distance of the heavy-category athletes, which could be a limiting factor for the achieved distance compared to the light-category athletes. The sit-and-reach scores for male athletes were generally similar to those found by De Oliveira et al. (2015) in regional MMA athletes (33.4 cm vs. 30.7 cm, respectively) and by Schick et al. (2010) in amateur MMA athletes (30.3 cm). For female athletes, the sit-and-reach score found in this study was similar to that reported by Soares (2018) for an elite MMA athlete competing internationally, with a score of 37 cm.

Isometric strength is the ability to contract muscles without producing any apparent movement, where the force exerted equals the resistance (Filho, Fernandes & Rocha, 2019). For handgrip strength, our results align with Bagley et al. (2017), who found an average value of 56 kgf for amateur MMA athletes. The average handgrip strength in semi-professional athletes was 53.5 kgf (De Oliveira et al., 2015). Regarding absolute and relative handgrip strength between light and heavy male athletes, our results are consistent with Folhes et al. (2022), who also observed no significant differences between these two categories in elite and professional athletes.

In contrast to the findings of Folhes et al. (2022) for absolute lumbar isometric strength (Elite Light vs. Heavy: 158 vs. 185 kgf; Professional Light vs. Heavy: 159 vs. 184 kgf, respectively), this study observed a significant difference between light and heavy male athletes, with a 12% higher value in heavy-category athletes. However, when considering values relative to body mass, neither our results nor those of Folhes et al. (2022) found significant differences between categories. For women, Soares (2018) observed an absolute lumbar isometric strength value of 131 kgf, a handgrip strength of 30.85 kgf, and scapular isometric strength of 29.6 kgf in a UFC-ranked athlete. Similar to Soares (2018), our results for handgrip strength were 40.1 kgf and for scapular strength were 28.4 kgf. However, for lumbar isometric strength, our average result was 20% lower.

Regarding aerobic endurance performance, athletes in this study showed an average VO_2max of 45 ml.kg.min^{-1} (SD = 10.5), which is relatively low compared to studies using a treadmill. In the Bruce treadmill test, semi-professional MMA athletes reached an average VO_2max of 57.4 ml.kg.min^{-1} (SD = 7.7) (Bernardi et al., 2019), and another study with amateur MMA athletes reported average VO_2max values of 55.5 ml.kg.min^{-1} (SD = 7.3) (Schick et al., 2010). However, a peak VO_2max value of 42 ml.kg.min^{-1} was reported in professional MMA athletes after an incremental treadmill test (Gonçalves, 2020). In female athletes, our relative VO_2max results were significantly higher than those previously reported in the literature for MMA athletes (Table 3). Soares (2018) reported a VO_2max value of 44.7 ml.kg.min^{-1} in an elite female MMA athlete after a treadmill test.

Among male UFC fighters assessed through running-based tests, heavy-category athletes had an average value of 39.9 ml.kg.min^{-1}, light-heavyweight athletes had 47.6 ml.kg.min^{-1}, and middleweight athletes had 49.7 ml.kg.min^{-1}; these categories collectively formed our group labeled as heavyweight. Lightweight, featherweight, and bantamweight UFC athletes had average values of 52.5 ml.kg.min^{-1}, 55 ml.kg.min^{-1}, and 54.2 ml.kg.min^{-1}, respectively (UFC PI, 2021). Together, these three categories represented the lightweight group in this study. In general, lighter athletes tend to have higher VO_2max values compared to heavier athletes; however, in the present study, we did not find significant differences between the categories studied.

Using a cycle ergometer with MMA fighters may not be the ideal technique as it violates the principle of specificity, given that it is not a common motor gesture in MMA and is rarely part of the athletes' preparation. Additionally, it involves less muscle mass during the test and may cause premature fatigue in the quadriceps femoris, which, in turn, elevates an important variable in the calculation of VO_2max: heart rate (Filho, Fernandes & Rocha, 2019). It could be said that the cycle ergometer test possibly underestimated the VO_2max of the participating athletes; however, it was the only resource available to assess the aerobic endurance of the individuals.

Conclusion

The results found in this study demonstrate the existence of differences in some anthropometric variables, somatotype, and physical valences among the categories of high-performance male athletes. In turn, the present work agrees with other studies reported in the literature, which contributes to strengthening research around MMA. In addition, the development and access to studies like this contribute to physical trainers, coaches and athletes planned in their competitive period. We recognize the limitation regarding the number of volunteers and measuring equipment, especially for VO_2max. However, our results highlight the need for future research with larger samples to better understand the morphological differences and physical patterns between MMA categories, especially among women.

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