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Anthropometric Profile Assessed by Bioimpedance and Anthropometry Measures of Male and Female Rugby Players Competing in the Spanish National League

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Abstract: Different rugby positions make different demands on players. It therefore follows that optimum body composition may vary according to the position played. Using anthropometry and bioimpedance analysis (BIA) to assess body composition, the present study aimed to compare the effect of sex and position on body composition variables using anthropometry and BIA methods. A total of 100 competitive rugby players (35 women and 65 men) competing in the First Spanish National League were recruited voluntarily and for convenience for this study. In the laboratory, body composition was assessed by anthropometry, following the recommendations established by the International Society for the Advancement of Kinanthropometry (ISAK), and by direct segmental multi-frequency BIA, following the guidelines established by the Spanish Group of Kinanthropometry (GREC) of the Spanish Federation of Sports Medicine (FEMEDE). We found sex-related differences in height, weight, body mass index and body fat (%) by anthropometry and in body lean mass (%) by DSM-BIA, in 4 of the 6 skinfolds assessed ($p < 0.05$). We also observed position-related differences in all the variables assessed ($p < 0.05$) except for lean body mass, as measured by both methods of determining body composition, and front thigh skinfold. Body composition and ∑6skinfolds differs according to sex and playing position, backs (16.6 ± 3.8% and 92.3 ± 33.9 mm,) vs. forwards (20.0 ± 6.7 and 115.3 ± 37.6 mm), and the muscle-adipose (meso-endomorphic somatotype) development predominated in both sexes. Thus, forwards of both sexes are taller, heavier and fatter, possibly due to the specific demands of this position. In addition, body composition measurements vary according to the method used (DSM-BIA vs. anthropometry), indicating that anthropometry is probably the best body composition assessment method.

Keywords: anthropometry; body composition; exercise; BIA; team sport

1. Introduction

Rugby is a competitive team sport played by two teams, each composed of 15 players: 8 forwards (two props and second rows, three back rows and one hooker) and 7 backs (two centres and wingers, one scrum half, fly half and fullback). The aim is to advance the ball down the field into the opposition's territory and score a try (touchdown) [1–3]. Rugby is a contact sport with matches lasting 80 min, divided into two halves of 40 min separated by a 10 min rest interval. The dynamic of the competition includes bouts of high intensity effort (i.e., sprinting and tackling) interspersed with low intensity efforts that include walking and jogging [4]. Approximately 84–95% of a match corresponds to low intensity activities [5]. Rugby requires a combination of endurance, strength, skill and speed [2]. Each position makes different physiological, technical and anthropometric demands on the player [6–8]; thus, the ratio of high to low intensity effort ranges from 1:6 (forwards) to 1:8 (backs) [5]. Backs spend more time in free running while forwards are frequently involved in a high number of physical collisions and tackles [9]. Consequently, speed and endurance are the most important physical attributes for backs, who must control possession of the ball once obtained by the forwards and accelerate away from opposition players to create scoring opportunities, as well as provide cover in defence [3].

The specific demand of each rugby position is reflected in differences between players. Thus, given the higher demand for speed and endurance in backs, these usually present a lower level of body fat [7,8,10] because body fat compromises acceleration, speed, tackling proficiency and thermoregulation [2,11]. In contrast, forwards need a higher body mass because this parameter is correlated strongly with scrummaging force [12] and the generation of momentum and impact forces [11]. Although rugby has traditionally been played by male teams, recent years have witnessed an increase in the number of female teams and leagues. However, female rugby players present lower physical fitness values (jump ability, speed and VO_{2max}) compared to men and other team sport modalities as hockey and soccer) [4].

Body composition can classified at various levels, including molecular, cellular, tissue, organic and global level [13]. However, body composition measurement has traditionally included a two-component model that distinguishes between fat and fat-free body mass [14]. Dual energy X-ray absorptiometry (DXA) measures bone body mass as well as fat and lean body mass, and has been proposed as the standard method for quantifying % body fat [15]. Nevertheless, anthropometry and bioelectrical impedance analysis (BIA) are also validated methods for assessing body composition in athletes [16,17]. Anthropometry measures various features (height, weight, girth, bone breadth and skinfolds) and regression equations are used to estimate body composition and somatotype [18], whereas BIA estimates body fat mass and lean body mass by administering a weak alternating electrical current which flow at various speeds depending on the composition of the body. The current is easily conducted by tissues rich in water and electrolytes, such as blood and muscles, and impeded in spaces filled with fat, bone and air [19,20]. A systematic review has reported that elite rugby players are taller, heavier and present a lower body fat mass and sum of skinfolds [21]. These differences in the body composition of players at different levels are supported by studies that have reported a moderate to strong positive relationship between lean body mass and jump ability and sprint [22] and a moderate negative relationship between skinfold thickness and tackling ability [23].

However, although various studies have related physical performance to anthropometric measurements [22,23] and compared junior to senior rugby players [24,25], most have focused on the male population. Furthermore, there is a limited knowledge about possible differences according to position or sex in competitive rugby players. In addition, no studies have compared the use of anthropometry and BIA to assess body composition in competitive rugby players. Therefore, the aims of the present study were: (i) to compare the effect of sex (male vs. female) and position (forwards vs. backs) on body composition and other anthropometric properties assessed by anthropometry; (ii) to compare the effect of sex (male vs. female) and position (forwards vs. backs) on body composition and other anthropometric properties assessed by BIA.

2. Materials and Methods

2.1. Design

This was an observational, descriptive study of the relationship between body composition, sex and playing position in competitive rugby players.

2.2. Sample

A total of 100 competitive rugby players (35 women and 65 men) competing in the First Spanish National League (*Liga Iberdrola* and *Division de Honor A*) participated voluntarily and for convenience in this study. All players had at least 5 years' experience of playing competitive rugby. They trained 4 days a week in sessions of 1.5 to 2 h, in addition to playing a weekly match. Players were categorised as forwards or backs for analysis and comparison. Forwards consisted of 22 women and 32 men, and backs of 13 women and 33 men. Volunteers attended an information session at which the research team explained the study aims and characteristics to them and they signed an informed consent form. This study was conducted in accordance with the Helsinki Declaration [26] and the project protocol was approved by the Ethics Committee of the Hospital Clínico San Carlos in Madrid (ref.: 19/518-E_TFM).

2.3. Anthropometric Assessment

Anthropometric assessment was performed in accordance with the recommendations of the International Society for the Advancement of Kinanthropometry (ISAK) [27] by a level II ISAK-accredited practitioner, accompanied by a level I ISAK-accredited practitioner recording the measurements. An intra-observer technical error of the measurement (TEM) of 5% for skinfolds and 1% for breadths and girths was considered for each measurement. The instruments used for anthropometric measurements consisted of a Holtain® wall stadiometer (precision ± 1 mm), a Seca® weight scale (precision ± 0.1 kg), a Holtain® bone breadth caliper (range from 50 to 570 mm), a Holtain® skinfold caliper (constant precision ± 10 gr·mm^{-2}, interpolation precision ± 0.2 mm), a Holtain® anthropometric tape (precision ± 1 mm) and complementary materials (e.g., a dermograph pencil to mark the subject). Measurements were taken in a room maintained a constant temperature of 24 °C, with participants wearing shorts. Two measurements were taken for height, body mass and girths (relaxed arm, flexed and contracted arm, mid-thigh and calf girths) and bone breadths (biepicondylar humerus, bistyloid and biepicondylar femur), and three for skinfolds (triceps, subscapular, iliac crest, abdominal, front thigh and medial calf). All measurements were taken in the morning (after at 8:30 am) and on the right side of the body, regardless of which side dominant [27]. For the present study we selected height, weight, body mass index (BMI), all the skinfolds assessed and the sum of 6 skinfolds. In addition, we estimated % body fat using Carter's equation [28] and muscular mass using Lee's equation [29]. To calculate the somatotype, we used the three-component system (mesomorphy, endomorphy and ectomorphy) proposed by Heath-Carter [30], thereby establishing the mean somatotype and position in the somatochart for male and female athletes.

2.4. Bioimpedance Assessment

Data were collected in accordance with the protocol and standards established in the Declaration of the Spanish Kinanthropometry Group (GREC) of the Spanish Federation of Sports Medicine (FEMEDE) [31] and the recommendations of Sergi et al. [32]. Direct segmental multi-frequency BIA was performed using the InBody 720 body composition analyzer (InBody Co. Ltd., Seoul, Korea). This machine makes a direct non-empirical estimation and uses an eight-point tetrapolar tactile electrode system (two for each hand and each foot) to take separate measurements of impedance in the subject's trunk, arms and legs at six different frequencies (1 kHz, 5 kHz, 50 kHz, 250 kHz, 500 kHz and 1000 kHz) for each of the body segments (left leg, right leg, left arm, right arm and trunk), and provides immediate and extensive quantitative values for various body composition parameters. The test was carried out by qualified personnel (J.J.R.-A.). Subjects wore normal undergarments and were advised to stand barefoot in an upright position with their feet on the foot electrodes on the machine platform and their arms abducted with their hands gripping the hand electrodes on the handles. In accordance with the manufacturer's guidelines, the participants wiped the soles of their feet with a proprietary electrolyte tissue before standing on the electrodes embedded in the scale platform.

2.5. Statistical Analysis

All variables are presented as mean (M) ± standard deviation (SD), after testing for normal distribution using the Kolmogorov–Smirnov test and for homogeneity the Levene's test. To detect possible differences in the variables assessed according to sex and position of the competitive rugby players, we performed a two-way ANOVA with the factors sex (male vs. female) and position (backs vs. forwards). When statistically significant differences were observed, a pairwise comparison was performed using a Bonferroni post hoc test.

The concordance between both methods (anthropometry and BIA) for the percentage of fat mass and muscle mass was evaluated using the Bland–Altman diagram. Heteroscedasticity was examined using the White test and the Breusch–Pagan test, checking the effect size. Finally, the Pearson correlation coefficient was obtained between all the variables.

Statistical significance was set at $p < 0.05$. All statistical analyses were performed using SPSS (version 18.0, SPSSTM Inc., Chicago, IL, USA).

3. Results

The mean age of male players was 20.6 ± 2.1 years for backs and 22.4 ± 4.5 years for forwards, whereas for female rugby players it was 21.9 ± 4.0 years for backs and 22.1 ± 4.4 years for forwards. No differences were observed by sex (p = 0.661), position (p = 0.360) or sex·position (p = 0.442). However, we did detect sex-related differences for height, whereby male players were taller (1.80 ± 0.01 vs. 1.64 ± 0.01 m, p = 0.030), and position, whereby forwards were taller (1.76 ± 0.10 vs. m, 1.71 ± 0.10 p = 0.030). For weight, we found a statistically significant effect of sex whereby males were heavier than females (90.1 ± 1.8 vs. 65.5 ± 2.0 kg, p < 0.001), and this effect was observed in forwards and backs alike (p < 0.001) (see Table 1). We also observed an effect of position on weight, whereby forwards obtained a higher value than backs (90.0 ± 17.0 vs. 69.8 ± 13.7 kg, p < 0.001) in male and female players alike (p < 0.001). Regarding BMI, we found statistically significant differences according to sex (p < 0.001) and position (p < 0.001), whereby males had a higher BMI than female rugby players (27.8 ± 0.6 vs. 24.2 ± 0.7 $kg \cdot m^{-2}$), an effect observed in forwards (p = 0.025) and backs (p = 0.002) alike, and forwards had a higher BMI than backs (28.9 ± 4.3 vs. 23.7 ± 3.2 $kg \cdot m^{-2}$, p < 0.001) in both male (p = 0.001) and female rugby players (p < 0.001).

Body fat (%) was higher in forwards than in backs, as assessed by anthropometry (20.0 ± 6.7 vs. 16.6 ± 3.8%, p = 0.009) and BIA (22.6 ± 9.7 vs. 17.3 ± 7.3%, p = 0.019). However, anthropometry detected statistically significant differences according to position in females (p = 0.030), differences that were not identified by BIA in either male (p = 0.063) or female rugby players (p = 0.141) (see Table 2). By sex, no differences in body fat were identified by BIA (p = 0.203), but anthropometry detected higher values for female rugby players (21.1 ± 1.1 vs. 16.3 ± 0.9%, p = 0.001) in backs (p = 0.001) but not forwards (p = 0.098). Regarding lean body mass (%), no differences were observed when comparing forwards and backs by either anthropometry (p = 0.748) or BIA (p = 0.145). Anthropometry did not identify differences in lean body mass in either sex (p = 0.059), whereas BIA detected higher lean body mass in male players (46.8 ± 1.7 vs. 37.3 ± 1.9%, p < 0.001) in both forwards (p = 0.046) and backs (p = 0.001).

Table 1. Height, weight and body mass index in rugby players of both sexes according to position.

Variable	Sex	Position		p-Value Sex	p-Value Position	p-Value Sex·Position
		Backs (n: 46)	Forwards (n: 54)			
Height (m)	Male	1.78 ± 0.07 *	1.82 ± 0.05 *	<0.001	0.030	0.980
	Female	1.62 ± 0.05 *	1.66 ± 0.08 *			
Weight (kg)	Male	80.1 ± 8.7 *,λ	100.1 ± 11.2 *,λ	<0.001	<0.001	0.452
	Female	57.5 ± 6.2 *,λ	73.5 ± 10.7 *,λ			
Body mass index (kg·m^{-2})	Male	25.6 ± 3.1 *,λ	30.3 ± 3.9 *,λ	<0.001	<0.001	0.955
	Female	21.7 ± 2.0 *,λ	26.7 ± 4.0 *,λ			

Data presented as M ± SD * Statistically significant differences ($p < 0.05$) according to sex for the same position; λ Statistically significant differences ($p < 0.05$) according to position within the same sex.

Table 2. Body composition in rugby players of both sexes according to position.

Variable	Sex	Position		p-Value Sex	p-Value Position	p-Value Sex·Position
		Backs (n: 46)	Forwards (n: 54)			
% Body fat anthropometry	Male	14.9 ± 4.1 *,λ	17.8 ± 6.8 *,λ	0.001	0.009	0.518
	Female	18.7 ± 1.9 *,λ	23.5 ± 4.8 *,λ			
% Body fat BIA	Male	16.4 ± 7.4 λ	21.0 ± 7.7 λ	0.203	0.019	0.652
	Female	18.4 ± 7.5 λ	25.2 ± 12.2 λ			
Fat mass anthropometry (Kg)	Male	12.4 ± 3.8 λ	18.0 ± 7.5 λ	0.275	<0.001	0.780
	Female	11.4 ± 2.1 λ	16.2 ± 6.1 λ			
Fat mass BIA(Kg)	Male	12.4 ± 5.7 λ	21.1 ± 8.7 λ	0.959	<0.001	0.844
	Female	12.6 ± 3.1 λ	20.6 ± 9.0 λ			
Muscle mass anthropometry (Kg)	Male	37.6 ± 3.4 *,λ	42.4 ± 4.5 *,λ	<0.001	<0.001	0.219
	Female	27.1 ± 2.5 *,λ	29.8 ± 3.7 *,λ			
Muscle mass BIA(Kg)	Male	39.5 ± 4.5 *,λ	44.5 ± 4.2 *,λ	<0.001 in Forwards <0.001 in Backs	0.183 in Female <0.001 in Male	0.030
	Female	26.6 ± 1.5 *	28.5 ± 4.4 *			
% Body lean mass anthropometry	Male	45.8 ± 3.2	41.6 ± 9.4	0.059	0.748	0.644
	Female	44.4 ± 1.2	41.8 ± 3.9			
% Body lean mass BIA	Male	48.1 ± 4.5 *	45.4 ± 4.4 *	<0.001	0.145	0.671
	Female	39.7 ± 14.1 *	34.8 ± 14.2 *			
Body lean mass anthropometry (Kg)	Male	69.6 ± 5.7 *,λ	79.8 ± 7.2 *,λ	<0.001	<0.001	0.059
	Female	49.4 ± 3.7 *,λ	54.3 ± 7.1 *,λ			
Body lean mass BIA(Kg)	Male	57.0 ± 26.0 *,λ	73.1 ± 19.8 *,λ	<0.001	0.024	0.279
	Female	35.2 ± 22.1 *,λ	40.9 ± 22.0 *,λ			

Data presented as M ± SD * Statistically significant differences ($p < 0.05$) according to sex for the same position; λ Statistically significant differences ($p < 0.05$) according to position within the same sex.

Table 3 shows the results for skinfolds. In a comparison of players according to sex, we observed differences in triceps, abdominal, front thigh and medial calf skinfolds. Abdominal skinfold values were higher in male than female rugby players ($p = 0.002$), in forwards ($p = 0.032$) and backs ($p = 0.023$) alike. Females obtained higher tricipital skinfold values than male rugby players (18.4 ± 1.3 vs. 14.6 ± 1.1 mm, $p = 0.029$), with statistically significant differences in forwards (p = 0.044). In addition, females presented a thicker front thigh skinfold (26.1 ± 1.6 vs. 18.0 ± 1.4 mm, p < 0.001) and medial calf skinfold (16.0 ± 1.1 vs. 10.6 ± 1.0 mm, p = 0.001), with differences in backs for this skinfold (p < 0.001). As regards the sum of six skinfolds, no differences were observed by sex (p = 0.605). In a comparison according to position, we found statistically significant differences for all the skinfolds except the front thigh skinfold (p = 0.057), with forwards presenting higher values than backs. However, in a comparison of position in each sex, statistically significant differences were only observed for the tricipital (p = 0.044) and iliac crest skinfolds in male backs (p = 0.023) compared to forwards. Subscapular skinfold values were higher in forwards than backs (16.7 ± 8.5 vs. 10.9 ± 4.0 mm, p = 0.005), in male (p = 0.037) and female rugby players (p = 0.45) alike. Forwards also presented higher medial calf skinfold values (14.0 ± 6.7 vs. 11.6 ± 5.5 mm, p = 0.045), but this statistically significant difference was only observed in female rugby players (p = 0.045). In relation to the sum of six skinfolds, we found differences in favour of forwards (115.3 ± 37.6 vs. 92.3 ± 33.9 mm, p = 0.028), but statistical significance was only reached in male rugby players (p = 0.032).

Table 3. Skinfolds in rugby players of both sexes according to position.

Variable	Sex	Position		*p*-Value Sex	*p*-Value Position	*p*-Value Sex·Position
		Backs (n:46)	Forwards (n:54)			
Triceps skinfold (mm)	Male	12.2 ± 5.0 $^{*,\lambda}$	16.9 ± 7.4 $^{\lambda}$	0.029	0.015	0.853
	Female	16.4 ± 4.7 *	20.4 ± 6.6			
Subscapular skinfold (mm)	Male	12.1 ± 4.9 $^{\lambda}$	17.5 ± 9.8 $^{\lambda}$	0.231	0.005	0.880
	Female	9.5 ± 1.9 $^{\lambda}$	15.5 ± 5.8 $^{\lambda}$			
Iliac crest skinfold (mm)	Male	13.5 ± 8.2 $^{\lambda}$	20.8 ± 10.7 $^{\lambda}$	0.268	0.020	0.509
	Female	12.4 ± 6.2	16.5 ± 7.5			
Abdominal skinfold (mm)	Male	21.4 ± 10.9 *	28.3 ± 10.6 *	0.002	0.001	0.746
	Female	12.6 ± 3.8 *	21.0 ± 6.1 *			
Front thigh skinfold (mm)	Male	16.1 ± 6.7	20.0 ± 8.7	<0.001	0.057	0.943
	Female	24.0 ± 7.1	28.2 ± 7.3			
Medial calf skinfold (mm)	Male	9.9 ± 6.5	11.4 ± 5.4 *	0.001	0.045	0.300
	Female	13.7 ± 3.2 $^{\lambda}$	18.3 ± 6.4 $^{*,\lambda}$			
Sum of 6 skinfolds (mm)	Male	86.5 ± 39.1 $^{\lambda}$	115.9 ± 41.1 $^{\lambda}$	0.605	0.028	0.504
	Female	98.5 ± 27.9	114.3 ± 32.1			

Data presented as M ± SD * Statistically significant differences (p < 0.05) according to sex for the same position; $^{\lambda}$ Statistically significant differences (p < 0.05) according to position within the same sex.

Regarding somatotype (see Figure 1), no statistically significant differences by sex were detected for any component (endomorph, p = 0.543; mesomorph, p = 0.146; ectomorph, p = 0.737). However, a comparison by position revealed a higher endomorph component in forwards compared to backs (p = 0.018), which only reached statistical significance in male rugby players (p = 0.013). The higher endomorph component paralleled a trend towards having a lower ectomorph component in forwards with respect to backs (p = 0.052), with no differences in the mesomorph component (p = 0.141). In general, muscle-adipose development predominated in both sexes.

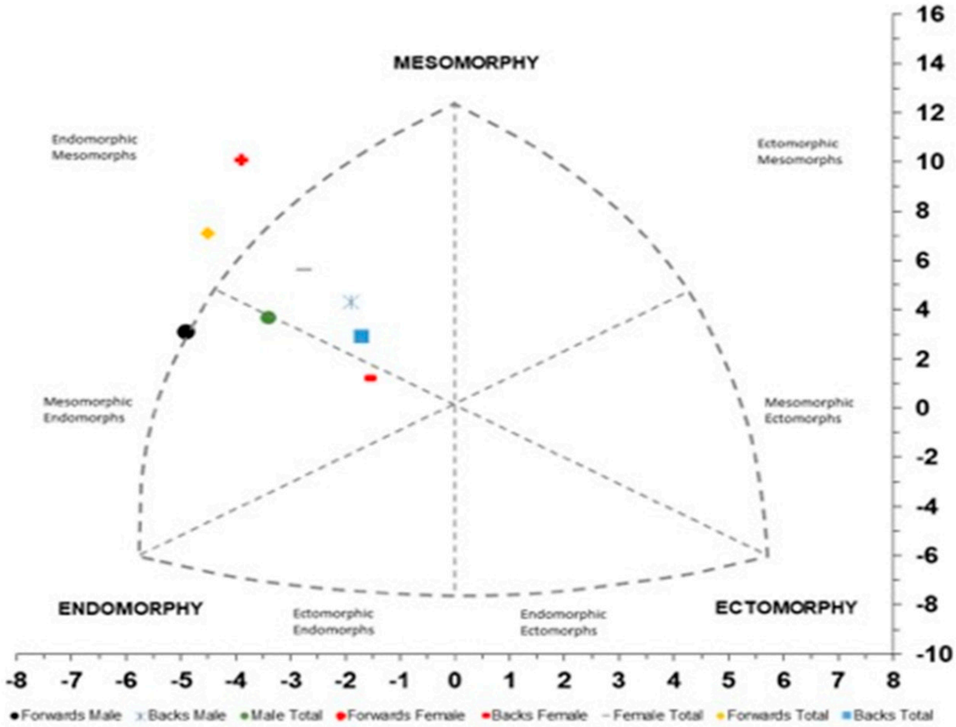

Figure 1. Somatochart of rugby players including both sexes and positions.

There is a concordance between the anthropometry and BIA in the fat mass percentage (ICC, Intraclass Correlation Coefficient, of 0.743 in women and 0.786 in men) and in the muscle mass percentage (0.663 in women and 0.748 in men). In the Bland–Altman graphs, an undervaluation of the BIA is observed when the value of the fat mass percentage is less than 15%, and an overvaluation when it is greater than 25%. This pattern is not seen in muscle mass percentage (Figures 2–5).

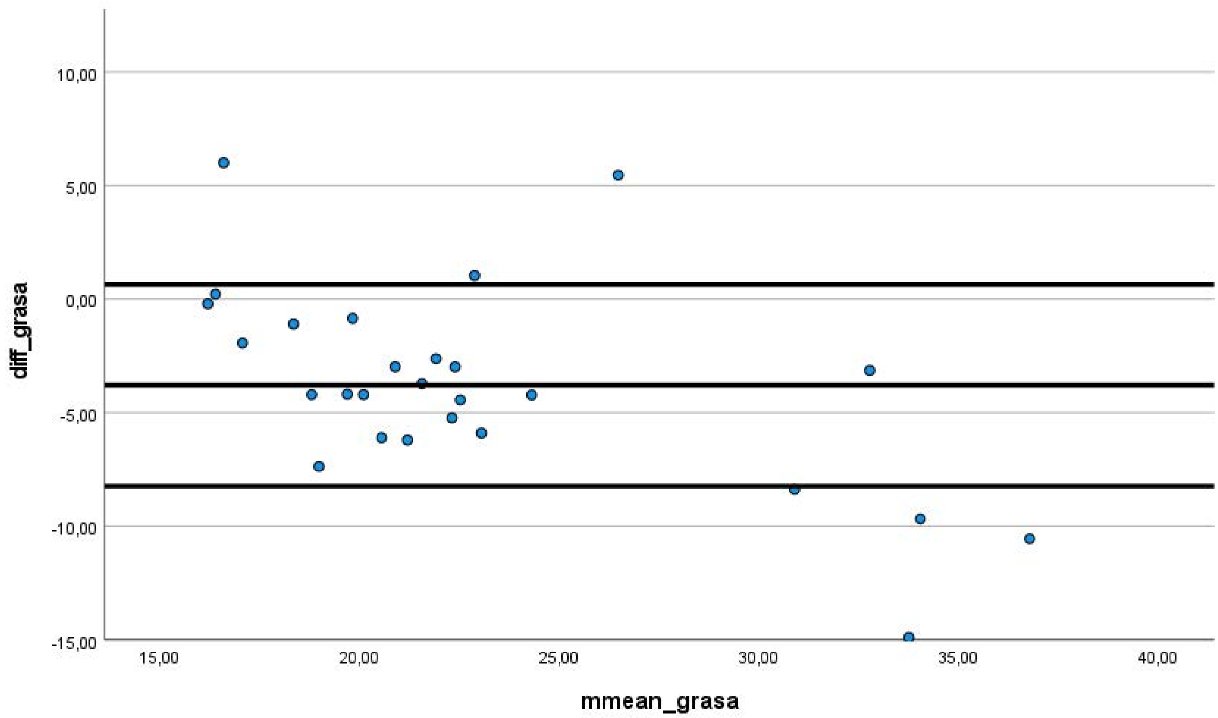

Figure 2. Bland-Altman graph of the fat mass percentage in women.

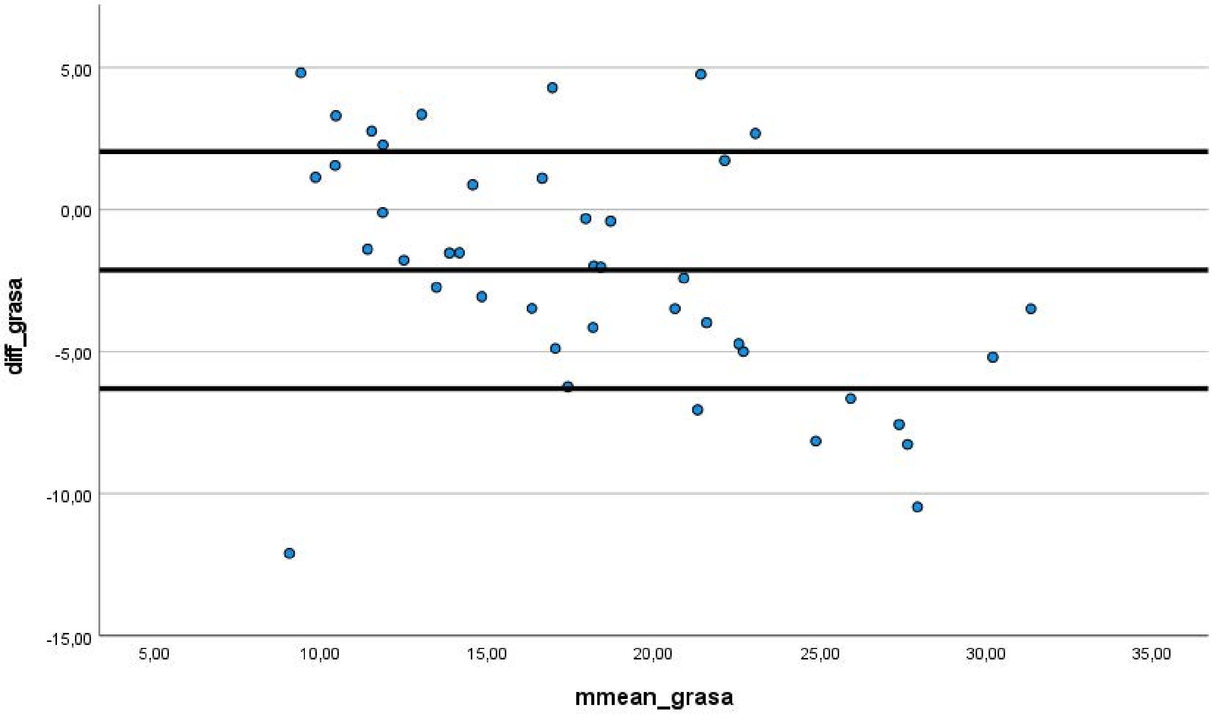

Figure 3. Bland-Altman graph of the fat mass percentage in men.

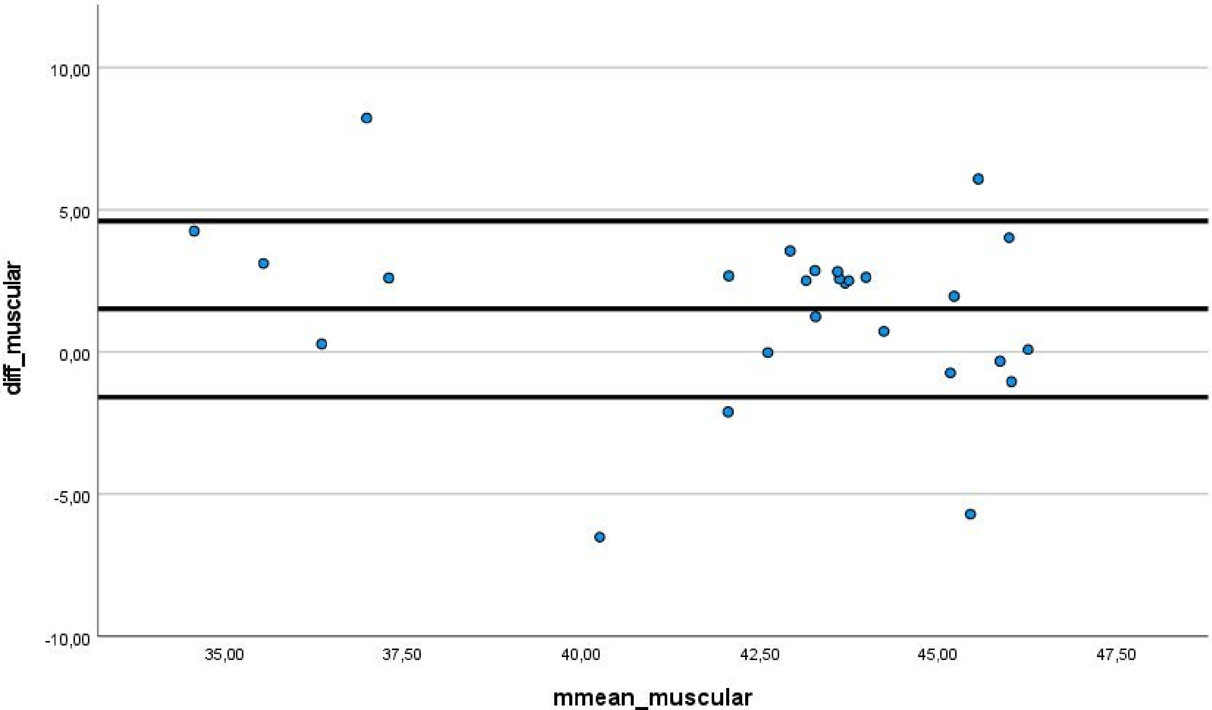

Figure 4. Bland-Altman graph of the muscle mass percentage in women.

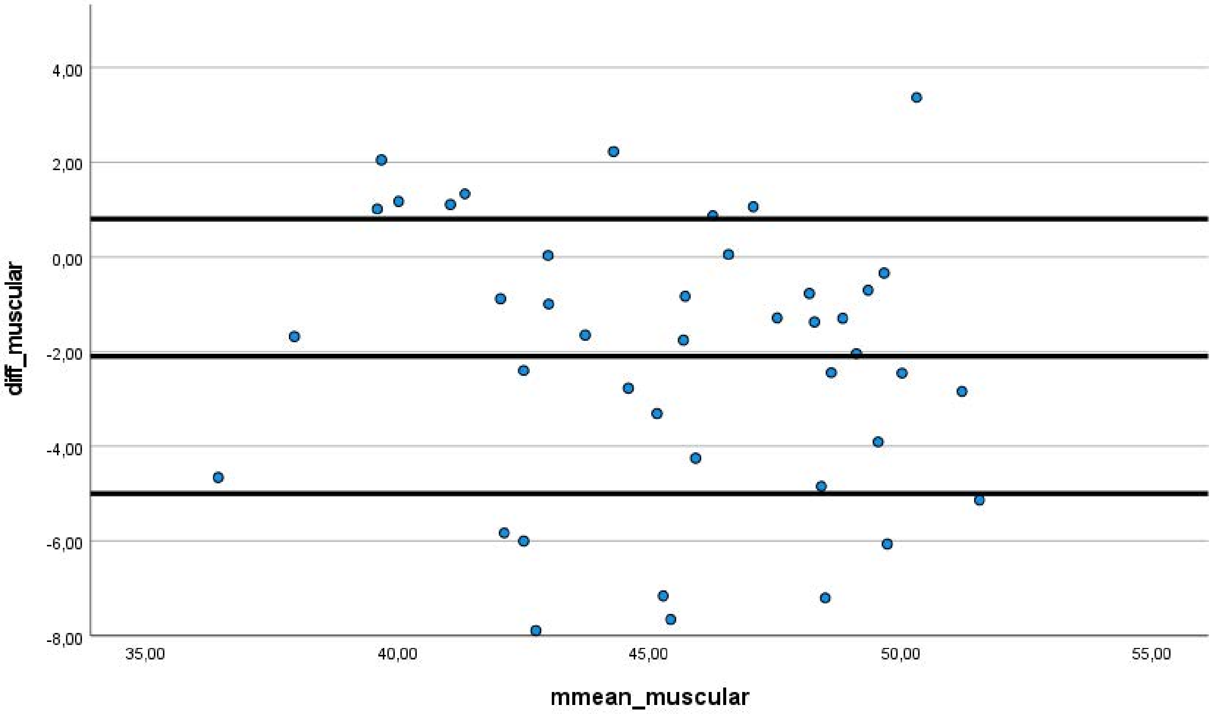

Figure 5. Bland-Altman graph of the muscle mass percentage in men.

Heteroscedasticity was not significant (White test, $p = 0.752$ and Breusch–Pagan Test, $p = 0.747$ for the fat mass percentage; and White Test $p = 0.745$ and Breusch–Pagan Test $p = 0.734$ for the muscle mass percentage). Differences were found between the two methods and gender for the muscle mass percentage ($p < 0.001$) with a high effect size (0.265). While for the fat mass percentage, no significant differences were observed ($p = 0.121$) with a reduced effect size (0.036). An underestimation of the BIA has been observed in women with respect to anthropometry in the muscle mass percentage (1.5074% below the mean), while in men there is an overvaluation by the same method (2.0982% above the mean).

Finally, the Pearson correlation index was performed between all the variables, where significant positive correlations were found between all the skinfolds and the fat mass percentage in both methods ($p < 0.05$). The muscle mass percentage showed a significant negative correlation with the skin folds in both methods.

4. Discussion

The results of this study revealed statistically significant differences in anthropometric measurements according to the position played and sex of competitive rugby players. Thus, forwards were taller, heavier and fatter than backs. In addition, forwards presented higher values for tricipital, subscapular, iliac crest, abdominal, front thigh and medial calf skinfolds and sum of six skinfolds. By sex, our results indicated lower values for height and weight in female competitive rugby players. As regards body composition assessed by anthropometry, we observed higher values for body fat and all skinfolds (except subscapular), whereas no differences in body composition were detected by BIA.

Our results are in accordance with other studies that have reported a greater height and body weight in forwards compared to backs in competitive rugby players from New Zealand [33,34], Australia [8] and Portugal [35], and in participants in the World Cup [36]. Having a higher weight correlates strongly with scrummaging force [12], a specific quality for forwards [37,38]. Nevertheless, a higher body weight could also diminish sprint ability and endurance performance if there is increased body fat mass. In this study, we found that increased weight in male and female forwards was accompanied by increased body fat and skinfold thickness, confirming the results of previous studies on male competitive rugby players [8,34,39], and now confirming the same relationship in female competitive rugby players. This characteristic body composition (heavier and fatter) in forwards could enhance scrummaging force [12] and endow advantages when competing for the ball in scrums, rucks and mauls by attenuating the transfer of forces and reducing risk of injury [6,10]. Nevertheless, the % body fat of male rugby players in this study was higher than that reported in competitive rugby players from countries that have obtained better results than Spain in international championships, such as New Zealand [33] and Australia [8]. Thus, this higher body mass that includes a higher fat mass in the Spanish players who participated in this study does not seem to provide additional benefits for specific abilities in rugby and could diminish tackling [23], acceleration and sprint [2] abilities. In contrast, the female rugby players in this study had less fat than South African competitive rugby players [40]. This lower body fat level might imply faster, higher acceleration in backs in Spanish competitive rugby, but could also result in a worse specific action that may contribute to Spain's moderate level of achievement in rugby. Regarding the sum of six skinfolds in Spanish elite rugby players, the mean in men was 75 mm in backs and 110 mm in forwards. In women, the mean was 60 mm in backs and 90 mm in forwards [41], and the average sum of six skinfolds was different in each sex. This finding has also been reported in other studies [33,42].

The lower level of body fat and higher lean body mass in male backs compared with forwards reported in this study are consistent with results previously reported for Australian [8], Argentinian [7], Italian [10] and Spanish [41] competitive rugby players. This body composition endows backs with the potential to improve tackling ability [23], acceleration and speed, and enhances thermoregulation [2,11], enabling them to cover a greater distance [5], increase acceleration during dynamic phases of the match and improve their role on the field [6,40,43]. One of the novelties of this study has been to confirm that these differences between positions observed previously in competitive male rugby players [7,8,10] and in the male participants in this study are also evidenced in female competitive rugby players.

Regarding the study participants' somatotype, this was similar to that reported previously, with a predominance of the mesomorph component [7,40,44–46], whereas the higher endomorph component of forwards could be advantageous for the continuous exposure to tackling and collisions [47].

Several studies have reported that different methods to assess body composition obtain different results [15,48–51]. One study of collegiate male rugby players reported differences in body fat as measured by BIA versus DXA [50], while in a sample of male competitive rugby players in another study of differences with BIA, anthropometry was consistent with DXA when detecting changes in body composition in competitive male rugby players [52]. Despite observing these differences, the use of different methods to estimate and analyse body composition can make it difficult to compare our results with other studies.

DXA appears to be the best assessment tool of body composition that should be chosen. However, given the simplicity, the speed and the frequency of which it can be used of the anthropometric method (skinfold technique) and in line with our results, the anthropometric measurements may provide a good method to body composition assessment [42].

It is important to note that BIA presents limitations in the assessment of body composition, as it underestimates fat mass and overestimates fat-free mass, hindering comparison [42,53]. However, if the evaluators have not been trained in anthropometric measurement procedures, the use of BIA is recommended as an alternative [42,53].

Some limitations must be considered when interpreting the results of this study. One of these is that there is little scientific literature on the topic, restricting comparisons and discussion of our results. Moreover, the methods used and analyses conducted of body composition have also differed between studies and these have been carried out mainly in male athletes, which also affects the above limitation. Nevertheless, this study is the first to have assessed body composition using BIA and anthropometry in male and female competitive rugby players, and we found that BIA is less sensitive than anthropometry for detecting differences in body fat. In addition, skinfolds have been confirmed as sensitive variables for detecting differences according to sex and position. Thus, this study contributes to the limited body of scientific knowledge related to rugby players, and its results suggest that anthropometry is a more accurate method for assessing body composition in competitive rugby players. In addition and given the competitive level of the athletes evaluated, our results on body composition and somatotype can be a reference for health and sports professionals and to establish a descriptive basis for this sport for future research.

5. Conclusions

Competitive rugby players present differences according to sex and position. Thus, forwards present greater height, weight and body fat, and thicker skinfolds, compared to backs, and these differences may reflect the specific actions of each position. However, BIA did not detect differences between male and female competitive rugby players. These results suggest that anthropometry is a more accurate method than BIA for assessing body composition in male and female competitive rugby players. The BIA underestimates in women and overvalues in men the fat mass percentage. In addition, it is necessary to establish two somatotype models based on position, with a higher body fat and endomorph component in forwards and a higher % lean body mass and lower body fat levels in backs.

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