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AVALIAÇÃO DA COMPOSIÇÃO CORPORAL DE ATLETAS BRASILEIROS DE GINÁSTICA AERÓBICA: UMA COMPARAÇÃO DE DIFERENTES MÉTODOS

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ASSESSMENT OF BODY COMPOSITION OF BRAZILIAN ATHLETES OF AEROBIC GYMNASTICS: A COMPARISON OF DIFFERENT METHODS

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Abstract

An adequate nutritional assessment is essential for planning strategies to enhance performance. In athletes, body composition must be monitored throughout training, since nutritional status can directly affect performance. The aim of this study was to describe body composition of Brazilian aerobic gymnasts and to compare three different evaluation methods, evaluating the clinical practice agreement between them. Six female professional athletes had their body composition evaluated by three different methods, namely skinfolds, octapolar bioimpedance and ultrasound, in two different moments of training, at the beginning of the season (M1) and one month after (M2). Comparison of body composition between M1 and M2 was made using Wilcoxon test and the fat percentage between the methods for M1 and M2 by Kruskal-Walis test. Agreement analysis between methods were performed using Bland-Altman plots. Median age of athletes was 22.5 [21.7-23.6] years and height was 1.60 [1.54-1.62] meters. The values of weight, fat-free mass, muscle mass and total body water were (53.5[50.9-57.5]kg; 41.7[39.7-46]kg; 22.9[21.8-25.5]kg; 30.5[29.2-33.8]kg) in M1 and (54[50.8-57.5]kg; 41.3[39.1-45.9]kg; 22.6[21.4-25.5]; 30.4[28.8-33.7]kg) in M2. The values of fat and percentage in M1 were (11.4[10.3-12.3]kg; 21.1[19.1-22.8]%) and M2 (11.9[10.5-12.7]kg; 21.5[19.4-23.7]%) with no statistical difference between studied moments. Comparisons of fat percentage between methods showed no difference in M1 and higher fat percentage evaluated by bioimpedance (21.6 ± 2.74%) in comparison to skinfolds (16.2 ± 2.71%; p=0.028) in M2. No difference in the body fat percentage between bioimpedance and ultrasound was detected. Only ultrasound and bioimpedance methods agreed with each other in Bland-Altman plots. The present study described body composition of elite athletes of Brazilian aerobic gymnastics athletes and found a possible subestimation of body fat using skinfolds methods. This study contributes, by producing specific knowledge, to the scientific development of the modality in both research and sports development, providing theoretical basis for the performance of professionals involved in the preparation of this athletes.

Keywords: *Ultrasound, Bioimpedance Analysis, Skinfold, Bodyfat Percentage.*

INTRODUCTION

A high performance sport is characterized by the constant search for maximum performance, aiming the best results in competitions. Considered a complex phenomenon, sports performance is influenced by several factors, and exploring the connection between nutrition, body composition and performance is fundamental in the training of any athlete (Potgieter, 2013).

Nutritional recommendations for athletes are different from the general population, and the higher the competitive level, the greater will be the concern in adopting assertive nutritional strategies. For this, carrying out an adequate nutritional assessment and following guidelines based on solid scientific evidence is of great importance to enhance the athlete results (Potgieter, 2013; Thomas, Erdman, & Burke, 2016).

Body composition is an important variable for sports performance, being decisive in sports that have division of categories by weight, which need a large amount of muscle mass to increase power and strength, in which athletes need to support their body weight and those in which the athlete's aesthetics are fundamental (Deminice & Rosa, 2009). There are several methods to assess body composition, each of which has positive and negative aspects in its use.

Several studies assess the body composition of athletes and sportspeople (Buscariolo et al., 2008; Mello & Rocha, 2015; Rossi & Tirapegui, 2001), however, there is still no consensus on the best method for this population, reinforced by the specificity of each sport and the feasibility of the methods. In addition, recent and non-Olympic modalities face a lack of studies, which makes it difficult to choose methods to determine the body composition of these athletes and can make nutritional recommendations less precise.

In this sense, there are gaps in the literature regarding recommendations for aerobic gymnastics (GAE) athletes, a modality recognized in 1995 by the International Gymnastics Federation (FIG). GAE is a modality in which continuous, complex and high-intensity movements are performed, followed by music, which require high levels of strength, flexibility and motor coordination (Alves et al., 2015). In addition to the interference of body composition in the athletics performance, as it is an aesthetic sport, athletes in the modality are subject to strong pressure to seek a lean body standard, which includes low levels of fat percentage and low body weight values (Silva et al., 2010).

Therefore, the objective of this research was to evaluate the body composition of Brazilian athletes of GAE in two different moments of the same training period using three different methods. The specific objectives were to describe the athletes' body composition and compare the results of body fat percentage obtained from ultrasound, bioimpedance and skinfold. By producing specific scientific knowledge, the research contributes to the development of the modality both in the academic environment and in the sports scenario, providing a theoretical basis for the performance of professionals involved in the preparation of the athlete.

METHODOS

This is a cross-sectional study with a quantitative approach with volunteer athletes recruited from the High Performance Aerobic Gymnastics Team at the Federal University of Lavras (GAE-UFLA). The criteria for participation were: being over 18 years old, being female, having at least 5 years of practice in the modality, having won a medal in the Brazilian championship of the modality in 2021. The present protocol was approved by the Ethics and Research Committee on Human Beings of the Federal University of Lavras (3.663.376) according to the guidelines of the Declaration of Helsinki.

Data collection was performed in two moments: on the first day of the annual training calendar (M1) and after 30 days (M2). Both evaluation moments took place in a single day, in the morning, having previously been required that the athletes did not drink alcohol 48 hours before, did not perform physical activity 24 hours before and were fasting for at least 4 hours (Bera, 2014). A vertical stadiometer (Sanny®) was used to measure height and a scientific adipometer (Cescorf®) for skinfold (SF) thickness. The measurement was performed in triplicate at the selected anatomical points (thigh, triceps and suprailiac) as proposed by Petroski (1999), inserted in the formula of Jackson & Pollock (1985) to estimate body density and later in the formula of Siri (1961) to estimate the fat percentage.

To perform the ultrasound (ULT), the BodyMetrix® BX200 device was used, having adopted the same anatomical measurement points of the skinfold protocol (Jackson & Pollock, 1985). The ultrasound device uses the principle of reflection and penetration of sonic waves (2.5 mHz) through tissues with different acoustic resistance (Kang et al., 2020).

In order to perform the bioimpedance (BIA), the InBody230 device was used, which has eight electrodes, two in contact with each hand and two in contact with each foot. The device transmits two frequencies of electric current (20 kHz and 100 kHz) through the

subject's body and measures the amount of body water, according to the conduction through non-conductive (adipose tissue) and conductive (fat-free tissue) tissues, estimating the percentage of fat (Biospace, 2006).

The data obtained were analyzed and ploted using the Jamovi software version 2.2.5 and GrandPad Prism version 8.0.2, adopting a significance level of $p<0.05$. Due to the small sample size, non-parametric tests were used. After the descriptive statistics, the Wilcoxon test was used to compare the results of each method of evaluating body composition between the two moments, the Kruskal-Walis with Dwass-Steel-Critchlow-Fligner Post-hoc test to compare the percentage of fat obtained between the methods in M1 and M2 and the Bland-Altman test to analyze the agreement between the methods at each moment. The Bland-Altman test verifies whether the methods are in agreement by analyzing the difference values, with perfect agreement being the value of zero, and the mean values, to identify whether the results obtained are within the confidence interval (Hirakata & Camey, 2009).

RESULTS

The studied sample consisted of six female athletes with a median age in years of 22.5 [21.7 - 23.6] and height in meters of 1.60 [1.54 - 1.62]. Table 1 presents the body composition components evaluated by bioimpedance. At M1, the median weight and fat percentage were 53.5 [50.9 - 57.5] kg and 21.1 [19.1 - 22.8] %, while at M2 they were 54 [50.8 - 57.5] kg and 21.5 [19.4 - 23.7] %, respectively. The values of the fat percentage obtained in each of the methods are represented in Table 2, and there was no statistical difference when comparing the different moments for each method.

Table 1. Body composition of six professional female athletes of GAE.

Variable	M1	M2	p
Weight (kg)	53.5 [50.9 - 57.5]	54.0 [50.8 - 57.5]	0.483
BMI (kg/m^2)	22.4 [20.2 - 23.2]	22.3 [20.4 - 23.2]	1.000
Fat (kg)	11.4 [10.3 - 12.3]	11.9 [10.5 - 12.7]	0.248
Fat-free mass (kg)	41.7 [39.7 - 46.0]	41.3 [39.1 - 45.9]	0.400
Skeletal muscle mass (kg)	22.9 [21.8 - 25.5]	22.6 [21.4 - 25.5]	0.583
Total body water (L)	30.5 [29.2 - 33.8]	30.4 [28.8 - 33.7]	0.438

* Values expressed in median [CI 95%]

Table 2 – Fat percentage of GAE athletes obtained from three methods at two different times.

Methods	M1 (n=6)	M2 (n=6)	p
Skinfolds	15.3 [13.7 - 19.3]	15.2 [14.1 - 18.4]	0.688
Ultrasound	21.1 [19.5 - 24.3]	19.3 [17.8 - 20.9]	0.063
Bioimpedance	21.1 [19.1 - 22.8]	21.5 [19.4 - 23.7]	0.178

* Values expressed in median [CI 95%]

Comparing the three methods evaluated (Table 3), a significant difference was found between the percentage of body fat assessed by skinfolds and bioimpedance only in M2 (p=0.028). Regarding the bioimpedance method, the values obtained through skinfolds underestimate the athletes' body fat percentage. Ultrassound and BIA showed similar results, while skinfolds method had lower body fat percentage, regardless the statistical significance.

Table 3 – Percentage of body fat analyzed by different methods of assessment of body composition and at different moments of training.

	SF	ULT	BIA
M1	15.3 [13.7 - 19.3]	21.1 [19.5 - 24.3]	21.1 [19.1 - 22.8]
M2	15.2 [14.1 - 18.4]	19.3 [17.8 - 20.9]	21.5 [19.4 - 23.7]*

Note: Values expressed in median [CI 95%]; SF= skinfold, ULT= ultrasound, BIA= bioimpedance; *P=0.028 compared to SF; Kruskal-Wallis with Dwass-Steel-Critchlow-Fligner Post-hoc comparisons.

The Bland-Altman plots represent, for M1 and M2, the agreement between the skinfolds and ultrasound (Figure 1), the skinfolds and bioimpedance (Figure 2) and the ultrasound and bioimpedance (Figure 3). The T test, used to evaluating whether the values of the differences are statistically different from zero, verified the agreement between the methods, having been identified agreement only between ultrasound and bioimpedance in both moments (p>0.05). The mean values found are within the lower and upper limits of the confidence interval. Also, it’s possible to observe that the values of bioimpedance are higher than those of ultrasound and skinfolds and that the values of skinfolds are lower than those of ultrasound and bioimpedance. Considering that bioimpedance and ultrasound showed to be in agreement, there is a tendency for the skinfold method to underestimate the athletes' fat percentage.

Figure 1 – Bland-Altman plots of skinfold and ultrasound.

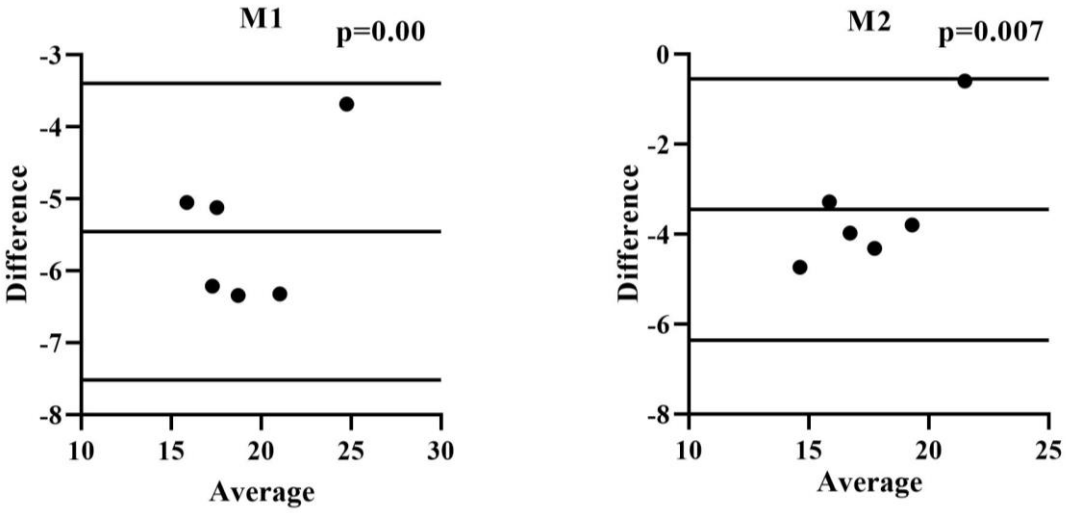


Figure 2 – Bland-Altman plots of skinfold and bioimpedance.

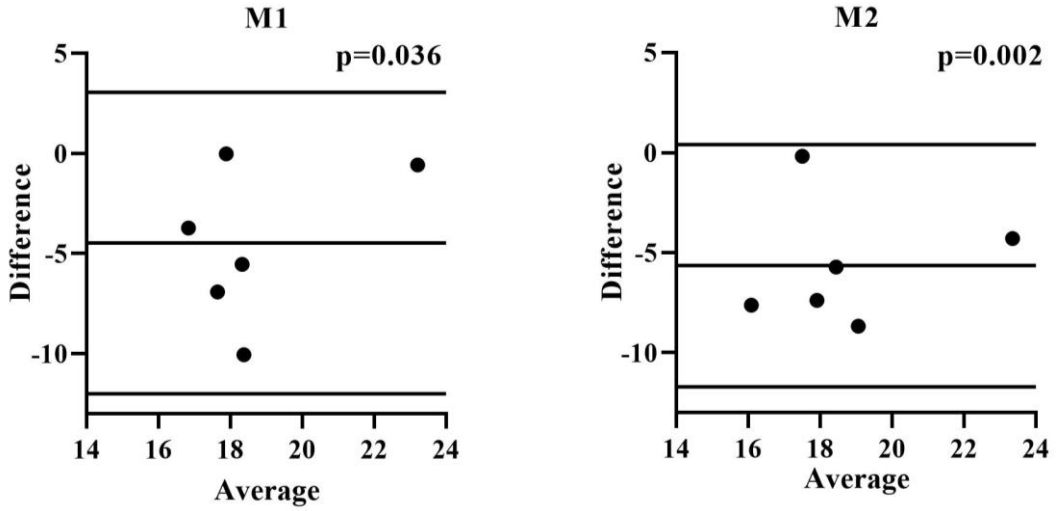
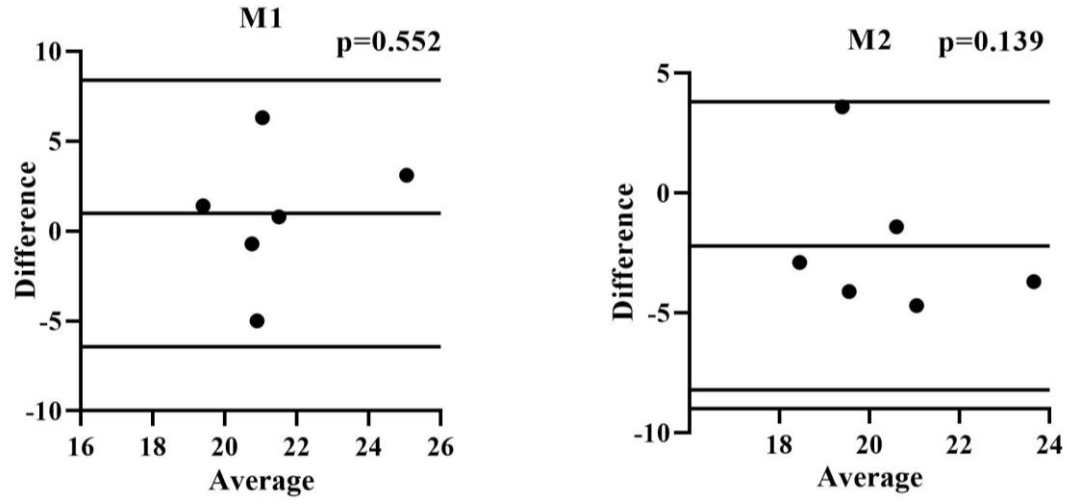


Figure 3 – Bland-Altman plots of ultrasound and bioimpedance.



DISCUSSION

In this study, the body composition of Brazilian aerobic gymnastics athletes was evaluated using three methods to estimate the percentage of fat. The results are able to describe the body composition of the gymnasts and do not demonstrate that there is a significant difference between the methods to estimate the percentage of fat, despite presenting only bioimpedance and ultrasound as concordant methods.

We did not find differences in body composition between the moments of training. It is noteworthy that our results do not show reductions in body weight and fat percentage as expected with the beginning of the training season (Bradley et al., 2015; Vercruyssen & Shelton, 1988). Possibly only one month was not enough to observe this body compostion changes.

The values of body fat percentage found are similar to those of other studies that evaluated female gymnasts of different modalities, like 19.7±4 (Fields et al., 2018) and 21.9±4.7 (Jakše, Jakše, Čuk, & Šajber, 2021). In the other hand, some values found for rhythmic gymnasts (14.3±5.6) and wheel gymnasts (12.67 ± 2.64; 15.74 ± 3.83) are lower (Villa, Villa-Vicente, Seco-Calvo, Mielgo-Ayuso, & Collado, 2021; Weber, 2022).

Regarding body composition, the scientific literature is scarce regarding specific data on aerobic gymnastics athletes. The only study found (Bedoya, Vernetta, & De la Cruz, 1995) evaluated 11 adult Spanish gymnasts of the modality, showing contrasting results, since the average fat percentage was lower (10.09±3.43), even with height (1.59 ±7 m) and weight (54±8 kg) similar to our study. However, it is known that different nationalities have different body patterns and that, due to advances in the scoring code and training methods, the characteristics of the morphological profile of athletes may change, requiring more recent studies to evaluate Brazilian gymnasts for later comparisons.

Comparing body composition data from female gymnasts can be considered a hard work, since the values of fat percentage are very variable between studies. This fact may be related to the different characteristics of the samples (age, competitive level), the training phases, since the athletes' body composition fluctuates throughout the season, the methods used for the evaluation (devices, equations) and the different characteristics between gymnastics modalities (Bacciotti, Baxter-Jones, Gaya, & Maia, 2017; Jakše et al., 2021). This specificity reinforces the importance of studies in each modality, in order to find the best evaluation methods for each population.

The three methods used in this research are accessible to clinical practice, in order to guide professionals involved in the preparation of athletes and provide practical applications. The three methods are doubly indirect, characterized by their low cost compared to the others (diluition tecniques, DEXA, plethysmography) and, despite performing different measurements like subcutaneous fat and total body water, they are capable of estimating the percentage of total body fat. he present study demonstrated that the medians of fat percentage by the skinfold method were lower than those obtained by ultrasound and bioimpedance, but without statistical difference.

Several studies that propose the comparison between different methods of assessing body composition in athletes and sportsmen of different modalities were analyzed in a systematic review (Martins, Alves, Sehl, Schneider, & Souza, 2019). The results were very discrepant, due to the variability of references, protocols, methods and individuals included in the studies. Despite this, there was a predominance of studies in which bioimpedance showed higher values of body components when compared to all other methods, which corroborates the higher values found in our study using bioimpedance in comparison to skinfolds. As bioimpedance primarily measures total body water, hydration levels can affect results and contribute to divergent results.

The same result was found in the study that evaluated the body composition of female soccer athletes (Buscariolo et al., 2008), in which the values of bioimpedance fat percentage were superior to the skinfolds in two different equations. The study indicated bioimpedance as a method that overestimates the percentage of fat, since the values found by the equations are similar to other studies. On the other hand, Brewer et al. (2019) evaluated athletes from different modalities, including gymnasts, and found that bioimpedance underestimated the percentage of fat by 2% when compared to DEXA, a method considered gold standard, suggesting that this is not an accurate method for evaluation of athletes.

In the study by Sangali et al. (2012), 15 elite Brazilian cyclists were evaluated and the skinfold and bioimpedance methods were compared with DEXA. The methods did not show agreement with DEXA, once skinfolds underestimated and bioimpedance overestimated the values. The authors attribute these results to the lack of specific equations for the modality, a fact that also occurred in the research in question.

Regardless if the value found being higher or lower, the non-agreement between the values obtained with the other methods strengthens the critical review carried out by

Deminice and Rosa (2009), which does not recommend the use of bioimpedance in athletes due to the great interference of sudden changes in the athlete's body in pre-training situations.

Since the results showed agreement between BIA and ULT, the validity of ULT for the assessment of fat percentage in gymnasts is questioned. Although the method presents high correlation values and high levels of agreement with DEXA for athletes in general (Kang et al., 2020; Loenneke, Barnes, Wagganer, & Pujol, 2014; Pineau, Filliard, & Bocquet, 2009) identified a total error of 4% compared to DEXA when evaluating 20 female gymnasts, suggesting that it may not be a valid method for estimating the percentage of fat in the population in question. The contrasting results found in the scientific literature indicate that the validity of the methods depends directly on the equation to be used and on the specificity in relation to the population in question, since there are numerous differences in the distribution of body adiposity between athletes from different sports (Deminice & Rosa, 2009).

Regarding the comparison between these three methods, the only study found evaluated male soldiers and found similar results (Neves, Ripka, Ulbritch, & Stadnik, 2013), demonstrating that the correlation between ULT and BIA was greater ($r = 0.767$) than BIA and SF ($r = 0.742$) and ULT and SF ($r = 0.709$). In the present study, the use of the Bland-Altman test made it possible to detect, in addition to the correlation, that the ULT and BIA methods are in agreement with each other. With this, it is suggested that more studies be carried out to compare the three methods, mainly associated with a gold standard method, such as DEXA.

The limitations of this study are related to the small sample size, the protocol used to carry out the assessment of the percentage of fat by the skinfolds and the non-use of a gold standard method. Although considered a small sample, this is representative of the population in question, since at the time of the research there were about 11 active adult athletes of the modality in Brazil (CBG, 2021). Regarding the protocol, we chose to use the 3-fold because it is equivalent to the one used in the BodyMetrix® software to calculate the percentage of fat by ultrasound, being a suggestion for future studies to create specific equations for gymnasts so that possible to make the measurement more reliable. The use of the other pattern was not possible in this study due to its high cost, limiting the conclusions regarding the best method to be used in this population.

CONCLUSION

The body composition of the Brazilian aerobic gymnasts evaluated in this study is similar to some studies, but differs from the numbers for rithymic and wheel gymnasts and Spanish aerobic gymnasts. It is necessary to perform more comparisons, especially within the same modality and using the same methods.

Regarding the methods for evaluating the percentage of fat, those used in this study do not present statistically different results and only the bioimpedance and ultrasound methods have concordant results. However, the lack of specific formulas and studies involving this population and the non-use of a gold standard method as a reference made it impossible to indicate the best method for evaluation.

This study highlights the scarcity of researches that assess the body composition of Aerobic Gymnastics athletes, which made some comparisons difficult. With this, it is suggested to carry out more studies within the modality, so that it is possible to base the work of professionals involved in athlete preparation.

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