Somatotype and body composition of university indor football players

Somatotipo y composición corporal de jugadores universitarios de fútbol bardas

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ABSTRACT

The purpose of this research was the characterization of the somatotype and composition and the relationship with physical abilities in university football players. The study was descriptive-correlational and included 21 university players from the Autonomous University of Sinaloa. Somatotype and body composition were determined by formulas such as bioimpedance and performance by measuring physical abilities. The somatotype value was 3.9, 4.7, 1.8, body fat was 23.6 ± 5.9% (bioimpedance), 17.6 ± 5.4% (Faulkner) and 14.9 ± 5.7 (Carter). Muscle mass was 47.5 ± 9.5 (bioimpedance) and 26.8 ± 5.6 (Lee). For V30M performance 5.1 ± 0.5, Illinois 16.9 ± 1.2, CNVO2max 42.2 ± 10.1 and Squat Jump 26.9 ± 8.6. Fat percentages and endomorphy value were significantly associated (p<0.05) with physical tests and muscle mass with the Lee formula. The bioimpedance and anthropometric methods presented correlation values of r=0.9 between them. The elements of fat and muscle present significant correlations with sports performance; while the Faulkner and Carter formulas presented high correlation with the bioimpedance method.

KEY WORDS: somatotype, body composition, sport performance.

RESUMEN

métodos de antropometría y bioimpedancia para masa grasa y masa muscular, así como la caracterización y relación del somatotipo y composición corporal con las capacidades físicas en futbolistas de bardas universitarios. El estudio fue descriptivo-correlacional incluyó 21 jugadores universitarios de la Universidad Autónoma de Sinaloa. Se determinó el somatotipo y la composición corporal por fórmulas como por bioimpedancia y el rendimiento por medio de medición de capacidades físicas. El valor de somatotipo fue de 3.9, 4.7, 1.8, la grasa corporal fue de 23.6 ± 5.9 % (bioimpedancia), 17.6 ± 5.4 % (Faulkner) y 14.9 ± 5.7 (Carter). La masa muscular fue 47.5 ± 9.5 (bioimpedancia) y 26.8 ± 5.6 (Lee). Para el rendimiento V30M 5.1 ± 0.5, Illinois 16.9 ± 1.2, CNVO2max 42.2 ± 10.1 y Squat Jump 26.9 ± 8.6. Los porcentajes de grasa y el valor de la endomorfia se asociaron significativamente (p<0.05) con las pruebas físicas y la masa muscular con la formula Lee. Los métodos de bioimpedancia y antropométricos presentaron valores de correlación de r=0.9 entre ellos. Los elementos de grasa y músculo presentan correlaciones significativas con el rendimiento deportivo; mientras que las fórmulas de Faulkner y Carter presentaron alta correlación con el método de bioimpedancia.

PALABRAS CLAVE: somatotipo, composición corporal, rendimiento deportivo*.

INTRODUCCIÓN

Athletes' sporting success is due to various factors, such as genetic makeup, training methods, body composition, physical condition, technical and tactical aspects, and mental health, among others; integrating all of these into the training process is the challenge facing college coaches (1,2,3).

While talent selection is an effective tool for achieving the best results in a given sport (4), it must be conducted at an early stage. However, many of these athletes do not go through this process and do not receive structured training in a sport until they reach the university level. In addition, in university sports, students fulfill the dual roles of athletes and students and must successfully balance both. On the one hand, they must fulfill academic responsibilities, and on the other, they must undergo highly demanding training to achieve high performance with the aim of securing spots in state, regional, and national competitions, thereby enhancing the prestige and reputation of their institution (5, 6).

From a sports perspective, it is important to consider various factors when planning training, such as conducting a comprehensive assessment and determining the impact of this variable on athletes' training, particularly for those participating in street soccer (7). Therefore, to achieve better competitive results and enhance athletic performance, it is necessary to assess physical fitness (8) and physical abilities, which have been shown to be closely related and to serve

as pillars of athletic performance (9), and to use this as a starting point for planning training based on objective parameters.

There are various strategies for assessing physical fitness, with anthropometry being one of the most widely used due to its benefits, as it allows for the assessment of athletes' morphology, proportionality, nutritional status, body composition, and somatotype (10,11) and is not limited to measuring fat mass and muscle mass alone (12,13,14). Another widely used method for this purpose is bioelectrical impedance (15,16,17,18). Both methods are classified as doubly indirect methods and use equations to estimate body composition; therefore, the use of both methods allows for an accurate assessment of the athlete.

Likewise, when discussing athletic performance, the specific physical abilities of soccer players are relevant for monitoring and adjusting training programs. There are various field and laboratory tests available to assess physical fitness, with field tests being an easy-to-administer, low-cost option that is both valid and reliable for this purpose (19, 20).

Although studies on indoor soccer in Mexico are scarce since research has focused on outdoor soccer due to its professional nature in recent years Mexico has entered professional indoor soccer leagues (Major Arena Soccer League), where it has achieved notable success, offering a pathway to professional sports for college athletes. Studies on body composition (21, 10), somatotype (11), and both variables together (22) and their effects on athletic performance (20, 23, 24), and the evaluation of these three groups of variables together (25) in indoor soccer players and in college indoor soccer players may be relevant and necessary to generate information on the relationship between these three elements, as well as for the characterization of this population and its association with physical abilities. Likewise, it is important to compare anthropometric and bioimpedance data in order to identify simple, rapid, effective, and cost-effective strategies for assessment and to determine their association with athletic performance. Therefore, the objective of this research was to identify the association between anthropometric and bioimpedance methods for fat mass and muscle mass, as well as to characterize somatotype and body composition and their relationship to physical abilities in university soccer players.

MATERIALS AND METHODS

Participants

This was a cross-sectional study with a correlational design involving 21 university futsal players from the men's and women's teams at the Autonomous University of Sinaloa. The participants included 10 women and 11 men, aged 18 to 23, who voluntarily agreed to participate in the study.

To be included, participants had to be members of the University's representative soccer teams, have been part of the team for at least two years,

and have completed all evaluations. It is important to note that the participants in this study comprise the entire roster of each category from the representative teams of the Autonomous University of Sinaloa.

The variables were somatotype, body composition (fat mass and lean mass), and physical abilities (endurance, speed, power, and agility).

Procedure

Prior to the assessments, a meeting was held at the Autonomous University of Sinaloa with administrators, coaches, and athletes to present the project and provide information on its objectives, the assessments to be conducted, and the impact and benefits for the institution, the coaches, and the athletes.

After the study was approved, the project was presented to the athletes, and they were informed that participation in the study was voluntary. The data from the anthropometric and physical fitness assessments were recorded in Microsoft Excel.

Instruments

Body Composition

Anthropometric measurements were taken using the restricted profile and were performed by certified personnel in accordance with ISAK (International Society for the Advancement of Kinanthropometry) guidelines. Weight was measured using a Tanita scale (RD-545PRO, InnerScan, Japan). Skinfold thickness was measured using a SLIMGUIDE (smartmet) skinfold caliper, body circumferences were measured with a LUFKIN tape measure, and femur and biestiloid diameters were measured (26). All measurements were taken in duplicate.

For the somatotype, the method of Carter (27) was used, in which the endomorphic, mesomorphic, and ectomorphic components are calculated through numerical operations using anthropometric measurements to determine their classification.

Body composition was determined using two different methods: the first involved bioelectrical impedance analysis (using a Tanita RD-545 PRO InnerScan scale and the "Healthy Edge Mobil" mobile app, https://play.google.com/store/apps/details?id=com.engsolinc.healthyedge) to calculate the percentages of body fat, muscle mass, and bone mass. The second method used the formulas proposed by the Spanish Group of Kinanthropometry (GREC) according to the type of population. Body fat percentage was calculated according to Faulkner (28) and Carter (29), and muscle mass according to Lee (31). In all cases, the anthropometric data for each athlete were included.

Physical abilities

The physical abilities assessed were endurance, speed, power, and agility. Endurance was assessed using the "Course Navette" test, which consists of a round-trip run over a flat 20-meter distance at an initial speed and pace of 8.5 km/h, with periodic increases of 0.5 km/h, marked by cones, where athletes increase their speed in accordance with the pace of an audio signal transmitted through a speaker. Until the athlete can no longer continue, the last number of the period mentioned by the audio is recorded, and VO2 max is then calculated using Leger's formula: VO2 max = 6V – 27.4, where V = the speed at which the athlete stopped (32).

Speed was assessed using a 30-meter straight-line sprint, in which the athlete covers the distance in the shortest possible time, starting from a crouching position upon the sound of a whistle. The test ends when the athlete crosses the 30-meter line. The course was marked with three cones, each placed 10 meters apart on the track; additionally, the "My Jump Lap Pro" app was used for measurement.

Lower-body power was measured via the vertical jump using the 'squat jump' test, supported by the My Jump Lap Pro app. Here, the subject starts with knees bent at 90°, hands on hips, and the torso held straight in a static position. Next, they jump vertically with as much force as possible without generating any bounce or counter-movement during the takeoff, keeping their hands on their hips at all times. Finally, upon landing, the legs must land extended with the feet in plantar flexion (33).

The Illinois Test was used to measure agility. The athlete completes a circuit in the shortest time possible, which is measured with a stopwatch. The circuit is a rectangular area measuring 5 x 10 m. It also consists of a total of three vertical rows, each spaced 2.5 m apart. The first and third columns are marked by two cones 10 m apart, and the second row includes four cones spaced 3.3 m apart. The circuit begins in the first row (from left to right) at the sound of a whistle; the athlete starts in a standing position behind the first cone, sprinting from the first cone to the second on the outside of the cones. Upon reaching the second cone, the athlete runs diagonally toward the opposite end of the field to the first cone in the second row, then performs a round-trip zigzag, starting from the right side of the initial cone (in the second row) to the last cone and back to the first cone in the second row. Then, the athlete heads diagonally toward the other end of the field to the second cone in the third row. Upon arrival, they sprint from the outer right side of the cones to the first cone in this row, finishing the drill upon passing this cone (34).

Statistical Analysis

The normality of the data was assessed; descriptive statistics are presented as the median and interquartile range (25th–75th percentiles). The

comparison between anthropometric and bioimpedance methods was performed by calculating the intraclass correlation coefficient (ICC), and Bland-Altman plots were used to assess the variation in the data. Spearman's correlation coefficients were calculated for all measured variables. Furthermore, the statistical analysis was performed using the STATISTICA software, version 8.0.

RESULTS

Table 1 shows the anthropometric characteristics of the youth soccer teams by gender and overall. Men had higher averages for weight, height, seated height, and arm span, as well as for subscapular and supraspinatus skinfold thicknesses and circumferences; women had higher averages for triceps, biceps, iliac crest, abdominal, thigh, and calf skinfold thicknesses.

Table 1. Anthropometric characteristics of youth soccer teams by gender and overall

	Women (N=10) Median (IIC)	Men (N=11) Median (IIC)	Total (N=21) Median (IIC)
Age (years)	20.0 (19.0-20)	20.7 (19.8-21.6)	20.4 (19.7-21.0)
Weight (kg)	57.5 (53.5-61.6)	72.3 (66.0-78.5)	65.2 (60.4-70.1)
Height (cm)	157.3 (153.2-161.4)	174.1 (169.3-178.9)	166.1 (161.2-171.0)
Seated height (cm)	86.3 (84.5-88.1)	91.9 (89.5-94.2)	89.2 (87.3-91.1)
Arm span (cm)	157.7 (152.9-162.4)	170.3 (147.8-192.7)	164.3 (152.9-175.6)
Triceps circumference (mm)	16.2 (13.3-19.1)	11.5 (7.2-15.9)	13.8 (11.1-16.4)
Subscapular circumference (mm)	12.9 (9.4-16.3)	13.4 (8.9-17.9)	13.1 (10.5-15.8
Biceps circumference (mm)	10.4 (8.4-12.3)	6.5 (4.1-8.9)	8.3 (6.6-10.0)
Iliac crest circumference (mm)	17.1 (13.4-20.8)	16.9 (10.5-23.2)	16.9 (13.5-20.4)
Supra-spinal circumference (mm)	12.1 (9.0-15.2)	12.5 (6.6-18.5)	12.3 (9.2-15.5)
Abdominal circumference (mm)	21.2 (18.1-24.3)	19.5 (11.8-27.3)	20.3 (16.4-24.3)
Thigh length (mm)	22.7 (17.5-27.9)	15.2 (9.1-21.2)	18.8 (14.7-22.8)
Leg length (mm)	14.3 (11.8-16.7)	10.7 (7.1-14.3)	12.4 (10.2-14.6)
Relaxed arm length (cm)	27.0 (25.4-28.6)	30.6 (28.5-32.7)	28.9 (27.4-30.4)
Contracted arm length (cm)	27.9 (26.5-29.2)	33.1 (30.9-35.3)	30.6 (28.9-32.3)
Waist circumference (cm)	73.9 (70.4-77.4)	81.6 (77.2-86.0)	77.9 (74.8-81.1)
Hip circumference (cm)	96.2 (93.6-98.7)	97.9 (94.5-101.3)	97.1 (95.1-99.1)
Mid-thigh circumference (cm)	51.9 (49.5-54.3)	54.1 (51.4-57.0)	53.1 (51.3-54.8)
Leg circumference (cm)	35.9 (34.9-54.3)	36.7 (35.3-38.1)	36.3 (35.5-37.1)
Humerus length (cm)	5.7 (5.6-5.8)	6.7 (6.6-6.9)	6.2 (6.0-6.5)
Biestiloid length (cm)	4.8 (4.6-4.9)	5.6 (5.4-5.9)	5.2 (5.0-5.4)
Femur length (cm)	8.4 (8.1-8.7)	9.7 (9.5-10.0)	9.1 (8.8-9.5)

Table 2 shows body composition and somatotype values, with women exhibiting higher body fat percentages than men across all three measurement methods (bioimpedance, Faulkner, and Carter); however, higher muscle mass values were observed in men (bioimpedance and Lee). Women exhibit greater endomorphic tendencies than men, while men exhibit greater mesomorphic and ectomorphic tendencies than women. The mean somatotype component values for women were 4.5, 4.3, and 1.4, which is classified as an endomorph-mesomorph somatotype; whereas for men, the values were 3.6, 5.1, and 2.2,

which is classified as a meso-endomorph somatotype. For the entire sample, the somatotype was classified as meso-endomorphic, as the somatotype component values were 3.9, 4.7, and 1.8.

Table 2. Body composition and somatotype

	Women (N=10) Median (IIC)	Men (N=11) Median (IIC)	Total (N=21) Median (IIC)
GBI Body Fat (%)	27.9 (25.0-30.9)	19.7 (16.7-22.7)	23.6 (20.9-26.3)
GF Body Fat (%)	21.1 (18.7-23.5)	14.5 (11.1-17.8)	17.6 (15.2-20.1)
GC Body Fat (%)	18.9 (16.4-21.4)	11.2 (8.0-14.5)	14.9 (12.3-17.5)
MMBI Muscle Mass (%)	39.3 (36.6-41.9)	54.9 (50.7-59.2)	47.5 (43.2-51.8)
MML Muscle Mass (%)	22.1 (20.8-23.4)	30.9 (28.1-33.8)	26.8 (24.2-29.3)
Endomorph	4.5 (3.6-5.3)	3.6 (2.3-4.9)	3.9 (3.2-4.7)
Mesomorph	4.3 (3.8-4.8)	5.1 (4.3-5.9)	4.7 (4.2-5.2)
Ectomorph	1.4 (0.8-2.0)	2.2 (1.3-3.0)	1.8 (1.3-2.3)

GBI: body fat measured by bioimpedance; GF: body fat calculated using the Faulkner formula; GC: body fat calculated using the Carter formula; MMBI: muscle mass measured by bioimpedance; MML: muscle mass calculated using the Lee formula.

In the correlations between body composition and athletic performance, it was observed that body fat percentage, as measured by bioimpedance, showed a positive correlation with the speed and Illinois tests; whereas a negative association was observed for the Course Navette test (CN periods, CN m, CN VO2max) and the Squat Jump test. Similarly, a positive correlation ($p<0.05$) was found between body fat percentage calculated using both formulas (Faulkner and Carter) and the speed test, although no associations were found with the other tests; for example, body fat percentage measured by bioimpedance and muscle mass measured by bioimpedance did not show any significant correlation. In the case of the speed and Illinois tests, the correlation was negative, as was the case with the Lee formula, which was significantly and negatively associated ($p<0.05$) with the speed test, while exhibiting a positive correlation with the Squat Jump. In the case of somatotype components (endomorph, mesomorph, and ectomorph), no significant correlation was found, but it was observed that the mesomorph and ectomorph components showed a negative correlation in the speed and Illinois tests (Table 3)

Table 3. Correlation between body composition and somatotype and physical abilities

	Speed (30 m)	Illinois	CN Periodes	CN (m)	CN VO2 MAX	Squat Jump
Weight (kg)	-0.483	-0.343	0.480	0.480	0.480	0.573
GBI (%)	0.877*	0.800*	-0.824*	-0.824*	-0.824*	-0.842*
GF (%)	0.863*	0.754	-0.761	-0.761	-0.761	-0.75
GC (%)	0.880*	0.796	-0.796	-0.796	-0.796	-0.762
MMBI (%)	-0.722	-0.555	0.679	0.679	0.679	0.785
MML (%)	-0.819*	-0.655	0.774	0.774	0.774	0.871*
Endomorph	0.736	0.628	-0.569	-0.569	-0.569	-0.586
Mesomorph	-0.089	-0.017	0.259	0.259	0.259	0.302
Ectomorph	-0.553	-0.558	0.425	0.425	0.425	0.356

*$P < 0.05$; BFA: body fat assessed by bioimpedance; BF: body fat assessed using the Faulkner formula; BF: body fat assessed using the Carter formula; SBM: skeletal muscle mass assessed by bioimpedance; SM: skeletal muscle mass assessed using the Lee formula.

An assessment of the equations' agreement with the BI (see Table 4) showed that, for estimating body fat percentage, the Faulkner and Carter formulas exhibited "good" statistical agreement, with the Faulkner formula performing better (CCS = 0.917, CCI = 0.735). In the case of muscle mass, Lee's formula (CCS=0.947) exhibits a "fair" statistical correlation.

Table 4. Spearman's correlation coefficient between bioimpedance and the anthropometric method

	CCS	CCI *
% Body fat		
BI- Faulkner	0.917**	0.735
BI-Carter	0.902**	0.640
Muscular mass		
BI-Lee	0.947**	0.476

CCS: Spearman's correlation coefficient; BI: bioimpedance; ICC: intraclass correlation coefficient.
*Very good: ≥ 0.75; Good: 0.75–0.5; Fair: 0.5–0.4; Poor: ≤ 0.04
**The correlation is significant if it is ≥ 0.5

The Bland-Altman plots used to assess the agreement between body fat percentage measured by bioimpedance and the Faulkner and Carter formulas indicated that the Carter formula showed a greater tendency toward the regression line, lower data dispersion, and a lower error trend than the Faulkner formula (Figures 1). Figure 2 shows the agreement between muscle mass as determined by bioimpedance and the Lee and formula. In both cases, a wide dispersion of data and a lower tendency toward the regression line were observed, as well as a higher error tendency compared to the degree of agreement for body fat percentage.
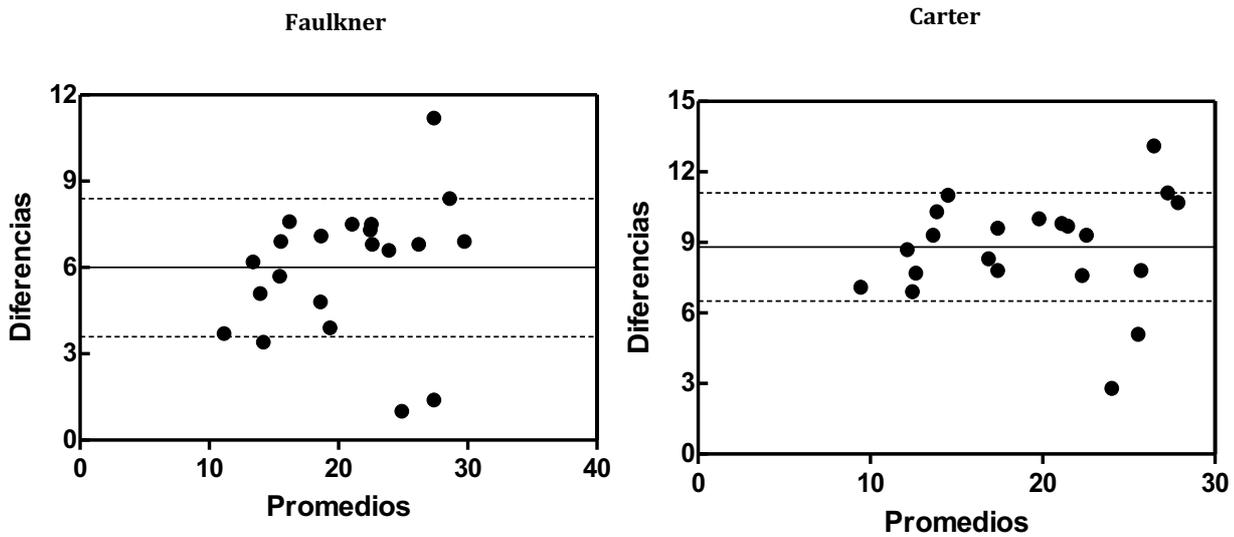
Faulkner

Carter

Figure 1. Agreement between body fat percentage measured by bioimpedance and the Faulkner formula and the Carter formula
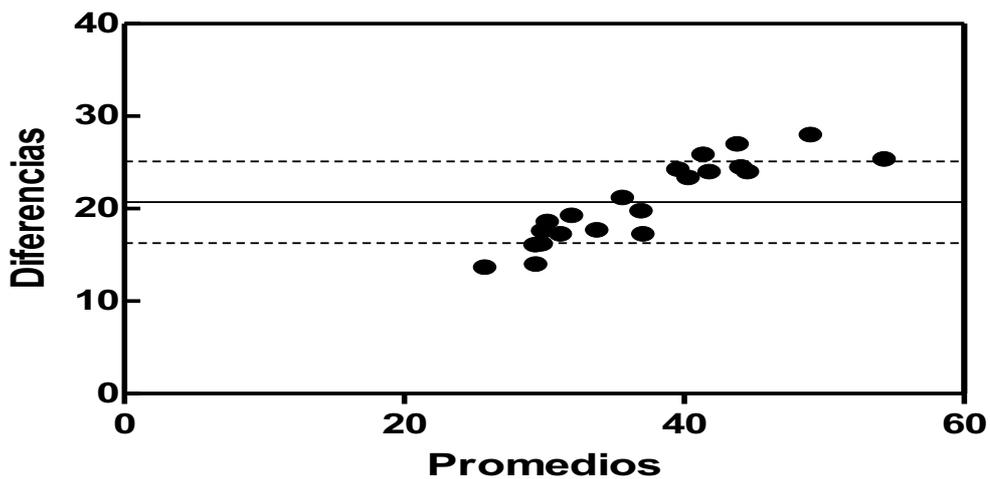
Figure 2. Agreement between muscle mass measured by bioimpedance and the Lee formula

DISCUSSION

The results of this study showed that the predominant somatotype in the women's team was endomorph-mesomorph (4.5, 4.3, 1.4), and these values differ from those previously reported (endo-mesomorph somatotype with values of 4. 1, 3.6, 2.1 (25) and 5.6, 3.3, 2.1 by Hall et al. (35); both in "bardas" soccer teams. This indicates that the 'bardas' soccer players in this study exhibit mesomorphic tendencies to a greater extent than those in other studies, which show endomorphic tendencies and, consequently, have lower fat levels and higher muscle levels (33). In the case of the men's team, the somatotype presented was meso-endomorphic (3.6, 5. 1.2.2), which is similar to another

study showing the same somatotype in street soccer players from the 2007 UAS team (2.7, 5.9, 1.7), but with higher levels of mesomorphy (10, 11).

The average body fat percentage of the women's and men's teams in this study, calculated using the Faulkner and Carter formulas, was similar to that reported in other studies. However, the bioimpedance data showed higher values than those reported in the literature (10, 21, 25). The values are consistent with anthropometric measurements and the use of formulas, which continues to support this method as reliable and comparable, unlike other methods that may vary depending on the device used and the equations it employs for component estimation.

Regarding muscle mass, García-Soidan (10) reports values close to those of our study and observes no significant differences when comparing anthropometric and bioimpedance methods for fat mass and muscle mass components in individuals under 30 years of age; furthermore, he notes that anthropometry is a more recommended method as a guide for observing changes due to training.

With regard to physical abilities and their relationship to body composition, correlations were found between body fat percentage and speed, yielding results similar to those of Ceballos (23), who also conducted this study on college athletes. We agree that body composition, specifically fat mass, is a factor that negatively influences both athletic performance and physical fitness in athletes; therefore, its control is essential within training programs.

On the other hand, when searching for studies similar to ours, we did not find many that examined the variables measured in this study within this population or that used any of these methods. The only study in which the variables were correlated was that conducted by Cejas (25), which measured the association between somatotype components (endomorph, mesomorph, and ectomorph) and body fat percentage using the vertical jump test with the CMJ30s test (continuous jump test). That study found a negative correlation between the endomorph somatotype tendency and relative power output during the 10-second period of the test. In this study, we evaluated the correlation of the same variables but using the vertical jump via the Squat Jump test, and whereas, in contrast to Cejas (25), we obtained similar results regarding the negative relationship with the endomorphic component, this was not statistically significant ($p > 0.05$). For males, no reference values were available.

It is worth noting that, following an exhaustive review of the literature on this sport regarding anthropometric variables, somatotype, body composition, and physical capacity, a notable lack of research was found. Furthermore, none of these reports used bioimpedance as a method for assessing body composition, nor did any of them evaluate agility. Similarly, none of them compared anthropometric methods with bioimpedance to determine body composition. Therefore, a strength of this study is that it addresses the aforementioned gaps, as this approach is novel, although a limitation is the small sample size.

In conclusion, body composition results obtained through bioimpedance and anthropometry vary, highlighting the importance of carefully selecting a method when assessing body composition.

When comparing body composition measured by bioimpedance to that measured by anthropometry, the Faulkner and Carter formulas yielded good correlation coefficients ranging from 0.75 to 0.5 (CCI) and ≥0.8 (CCS) for body fat percentage, whereas the other formulas did not show good correlation coefficients. In addition, relationships were found between fat mass and speed and power, while somatotype did not show significant correlations with athletic performance.

LIMITATIONS

One of the limitations of this study is the sample size, as it is limited to teams representing the Autonomous University of Sinaloa. However, it is necessary to expand the sample to include players from other universities in order to strengthen the analysis and the correlations found; therefore, this study can be considered a pilot study.

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