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ORIGINAL RESEARCH

Anthropometric characteristics, body composition and somatotype in players of a professional male soccer club from Caldas (Colombia)

Características antropométricas, composición corporal y somatotipo en jugadores de un equipo profesional de fútbol masculino de Caldas (Colombia)

Dagoberto Santofimio-Sierra[1] Yesid Calle-Pérez[2] Kevin Alejandro Gómez-González[3] Natalia del Carmen Ceballos-Feria[4]

[1] Universidad Surcolombiana - Faculty of Health Sciences - Department of Public Health - Medical Program - Neiva - Colombia.
[2] Government of Caldas - Ministry of Sport and Recreation - Manizales - Colombia.
[3] Centro de Salud Física Worldfitness - Medellín - Colombia.
[4] Deportivo Independiente Medellín - Nutrition Service - Medellín - Colombia.

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Corresponding author: Dagoberto Santofimio Sierra. Departamento de Salud Pública, Facultad de Ciencias de la Salud, Universidad Surcolombiana. E-mail: dagosanto@gmail.com.

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Abstract

Introduction: Multiple studies have analyzed the anthropometric characteristics of professional soccer players. However, carrying out studies describing such characteristics according to their playing position is pertinent.
Objective: To describe the anthropometric characteristics, body composition and somatotype of professional male soccer players from a club in Caldas (Colombia) according to their playing position.
Materials and methods: Descriptive cross-sectional study conducted in 28 professional soccer players from a club in Caldas. Body composition was estimated using the five-way fractionation method and was described according to the playing position. The differences between anthropometric indicators, body composition percentages, and somatotype according to the playing positions were evaluated using different statistical tests (ANOVA, Kruskal-Wallis test and Chi-square test).
Results: Participant's mean age, weight, and height were 24.9±5.74 years, 68.8±8.62kg, and 173±5.2cm, respectively. The median BMI was 22.9 (IQR=3.97kg/m²), being higher in midfielders (25.1; IQR=3.80kg/m²). The mean body adiposity percentage was 29.9±8.86%, being higher in goalkeepers (35.1±12.9%). The median muscle mass percentage was 44.7 (IQR=10.6%), being higher in forwards (49.9; IQR=7.2%). Regarding the somatotype classification, 35.71% of the players had an endo-mesomorphic type, with a statistically significant difference between the frequency of this body composition and the presence of other somatotypes (p=0.02), and being more frequent in forwards and midfielders (4 of 7 players and 3 of 5 players, respectively).
Conclusions: Differences in some anthropometric variables and somatotypes were identified in the players according to their playing position.

Resumen

Introducción. Múltiples estudios han analizado las características antropométricas en futbolistas profesionales. Sin embargo, es pertinente realizar estudios que describan estas características según la posición de juego.
Objetivo. Describir las características antropométricas, la composición corporal y el somatotipo de jugadores profesionales de fútbol masculino de un club de Caldas, Colombia, según su posición de juego.
Materiales y métodos. Estudio transversal descriptivo realizado en 28 futbolistas profesionales de un equipo de Caldas. Se estimó la composición corporal utilizando el modelo de fraccionamiento de cinco componentes y se describió según la posición de juego. Las diferencias en los indicadores antropométricos, los porcentajes de composición corporal y el somatotipo según la posición de juego fueron evaluadas usando diferentes pruebas estadísticas (ANOVA, prueba de Kruskal-Wallis y prueba Chi cuadrado).
Resultados. La edad promedio fue 24.9±5.74 años; el peso corporal promedio, 68.8±8.62kg, y la estatura promedio, 173±5.2cm. La mediana del IMC fue 22.9 (RIC=3.97kg/m²), siendo mayor en los mediocampistas (25.1; RIC=3.80kg/m²). El porcentaje de adiposidad promedio fue 29.9±8.86%, siendo mayor en los porteros (35.1±12.9%). La mediana de porcentaje de masa muscular fue 44.7% (RIC=10.6%), siendo más alta en los delanteros (49.9; RIC=±7.2%). Respecto a la clasificación del somatotipo, 35.71% de los futbolistas tenía un componente endo-mesomorfo, observándose una diferencia estadísticamente significativa entre la frecuencia de esta composición y los demás somatotipos (p=0.02), y siendo más frecuente en los delanteros y mediocampistas (4 de 7 jugadores y 3 de 5 jugadores, respectivamente).
Conclusiones. Se identificaron diferencias en algunas variables antropométricas y en el somatotipo de los futbolistas según su posición de juego.

Introduction

Anthropometry is a scientific discipline that studies the dimensions of the human body through measurements such as weight, height, body diameters and circumferences (head, waist, etc.), and skin folds.[1] Although there are different methods to evaluate body composition, the five-way fractionation method (skin mass, adipose mass, muscle mass, bone mass, and residual mass) is one of the most widely used in athletes as it allows making training modifications depending on the objectives established by their team.[2,3]

Optimal body composition for health is defined by genetic factors, sex, age, somatotype, physical activity, and nutritional aspects.[4] In the case of soccer, the physical demands of players have changed, so body composition and ideal somatotype requirements must be adapted to the present day. Therefore, it is necessary to monitor these anthropometric variables, as well as other indicators, to constantly improve the physical condition of athletes and, consequently, prevent the risk of injury and improve performance in factors such as speed, strength, and power.[3,5]

Several studies have analyzed anthropometric profiles in soccer players through different measurement methods and have been able to establish specific characteristics in these athletes that serve as reference data at different levels of performance.[2,5-7] However, carrying out body composition studies in professional soccer players using the five-way fractionation method is pertinent, as it is a valid reference for the monitoring and follow-up of these athletes.[3] These studies should also consider anthropometric characteristics and body composition based on the playing position, given that some research has suggested that there may be differences between these variables which, in turn, may affect the athlete's training and performance.[2,3]

Accordingly, the objective of the present study was to describe the anthropometric characteristics, body composition, and somatotype of professional male soccer players of a Colombian club depending on their playing position.

Materials and methods

Study type and sample

Cross-sectional analytical study carried out in 28 soccer players over 18 years of age from a soccer club in Caldas (Colombia) of the third division of the Colombian professional soccer league.

Procedures

Each player was assigned a code in a database in order to guarantee the confidentiality of their data. To take the anthropometric measurements, the athletes were summoned between 7 and 11 a.m., before their regular physical training, to an office in the soccer club's high-performance center. They were asked to fast and urinate before the evaluation and were advised not to eat or drink high amounts of water the night before or drink alcoholic beverages in the last 5 hours. The measurements were taken during individual sessions, in which the soccer players only wore shorts. The anatomical reference sites were marked on the right side of the body with a white demographic pencil. This was done following the International Anthropometric Standardization Reference Manual by a certified level 2 anthropometrist. The manual was edited in 2019 by the

International Society for Advancement of Kinanthropometry (ISAK) and has a technical measurement error (intra- and inter-evaluator) within the limits recommended by the ISAK itself (<5% for skinfolds and 1% for the remaining measurements).[8]

Each participant was subjected to the following measurements, which were recorded in duplicate with decimals:

- Body mass: it was measured using an OMRON HBF-514C Body Composition Monitor (capacity of 150kg and accuracy of 100g).
- Height: it was measured using a SECA 213 stadiometer (measuring range up to 205cm and accuracy of 1mm).
- Sitting height: it was measured with a SECA 213 stadiometer using a wooden AnthroFlex Anthropometric Bench (40cm high, 50cm long, and 30cm wide).
- Arm span: it was measured by placing a millimeter tape measure against the wall of the office (range of 1 250-2 250mm and accuracy of 1mm).
- Body mass index (BMI): it was calculated using the Quetelet index (BMI=weight [kg]/ height [m^2]).
- Skin folds: 8 skin folds were measured (triceps, subscapular, biceps, iliac crest, supraspinal, abdominal, thigh, and leg) using a Slim Guide caliper (0.5mm accuracy).
- Bone diameters: 9 bone diameters were measured (biacromial, anteroposterior abdominal, bicristal breadth, transverse thorax, anteroposterior thorax, humerus, bi-styloid, femur and bimalleolar) using Holtain or Rosscraft Campbell 10 anthropometers (calibers adapted to a measurement range of 15cm and an accuracy of 1mm) for small bones and a Cescorf anthropometer (accuracy of 1mm) for large bones.
- Bone lengths: 9 lengths and heights were measured (acromiale radiale, radiale-stylion length, midstylion-dactylion length, iliospinale height, trochanterion, trochanterion-tibiale laterale, tibiale laterale to floor, foot length, tibiale mediale-sphyrion tibiale) using a Cescorf anthropometer (1mm accuracy).
- Body girths: 13 girths were measured (head, neck, relaxed arm, flexed and contracted arm, forearm, wrist, thorax, waist, hip, proximal thigh, mid-thigh, leg, and ankle) using a Lufkin W606PM tape measure (accuracy of 0.1cm).

Body composition analysis

Body composition was analyzed using the five-way fractionation method proposed in 1991 by Kerr and Ross, which takes into account muscle, adipose, bone, residual, and skin tissues.[3,9] Somatotypes were classified using the method proposed by Heath and Carter in 1967, which considers the endomorph, mesomorph, and ectomorph types.[10] Finally, the waist–hip ratio was calculated by dividing the waist circumference value (minimum abdominal circumference) by the hip circumference value (maximum gluteal circumference). The results were presented as absolute values (kg, cm, mm) and relative values (%), and calculated by means of a spreadsheet created in Microsoft Excel.

Data analysis

The descriptive analysis of the data was performed by calculating absolute and relative frequencies for qualitative variables, and measures of central tendency (means and medians) and dispersion (standard deviations and interquartile ranges) for quantitative variables according to the distribution of the data determined through the Shapiro-Wilk test.

On the other hand, to evaluate the differences between the measurements of anthropometric and body composition indicators and the values of the somatotypes according to the playing position (goalkeeper, defender, midfielder, or forward), we used the analysis of variance test (ANOVA) for variables with a parametric distribution of the data and the Kruskal-Wallis test for those with a non-parametric distribution. Furthermore, differences in qualitative variables according to playing position were evaluated using the Chi-square test. Data were analyzed using the statistical package Jamovi® version 2.3.2. and a statistical significance level of $p<0.05$ was considered for all tests.

Ethical considerations

The study was approved by the Institutional Human Research Ethics Committee of the Universidad CES as per Minutes No. 190 of April 4, 2022. It also followed the ethical principles for biomedical research involving human subjects established in the Declaration of Helsinki[11] and the scientific, technical and administrative standards for health research set forth in Resolution 8430 of 1993 of the Colombian Ministry of Health.[12] Likewise, both the players and the team managers signed an informed consent form prior to their inclusion in the study. The information collected was protected by a password and, as mentioned above, each player's identification number was assigned a different code to ensure their anonymity and the confidentiality of their data.

Results

The mean age of the soccer players evaluated was 24.9±5.74 years. 25% (n=7) of the participants were forwards, 14.28% (n=4) were goalkeepers, 42.86% (n=12) were defenders, and 17.86% (n=5) were midfielders. All anthropometric measurements are presented in Table 1.

The mean values of waist–hip ratio, sum of six skin folds, and sum of eight skin folds were 0.84±0.06mm, 78.8±31.4mm, and 105±41.9mm, respectively. Moreover, the median BMI was 22.9 (IQR=3.87kg/m^2). Table 2 shows the measurements of the different anthropometric and body composition indicators, as well as the values of the somatotype components.

Table 1. Anthropometric characteristics of the sample (n=28).

Characteristics		Mean	Median	SD	IQR	*p*-value *
Age (years)		24.9	22.8	5.74	7.68	0.004
Basic measurements	Body mass (kg)	68.8	69.2	8.62	10.5	0.037
	Height (cm)	172	173	5.20	8.18	0.574
	Sitting height (cm)	90.4	91.0	2.94	4.38	0.154
	Arm span (cm)	174	174	5.77	7.95	0.391
Skin folds	Triceps (mm)	10.2	10.0	3.83	4.85	0.099
	Subscapular (mm)	13.1	11.0	4.66	6.25	0.027
	Biceps (mm)	6.13	5.00	3.12	4.00	0.002
	Iliac crest (mm)	20.1	15.5	9.32	16.9	0.108
	Supraspinal (mm)	11.2	11.0	5.00	9.88	0.019
	Abdominal (mm)	22.7	19.6	11.8	16.1	0.301
	Thigh (mm)	13.0	12.0	5.11	8.10	0.204
	Leg (mm)	8.62	7.00	4.61	4.25	0.001

Table 1. Anthropometric characteristics of the sample (n=28). (Continued)

Characteristics		Mean	Median	SD	IQR	*p*-value *
Body girths	Head (cm)	55.9	56.0	1.30	2.00	0.037
	Neck (cm)	36.4	36.3	2.70	3.00	0.247
	Relaxed arm (cm)	29.4	29.8	2.93	4.10	0.851
	Flexed and contracted arm (cm)	30.4	30.9	2.87	3.98	0.362
	Forearm (cm)	25.6	25.7	2.38	3.25	0.886
	Wrist (cm)	16.1	16.0	0.773	1.22	0.141
	Chest (cm)	93.3	92.3	6.08	8.85	0.590
	Waist (cm)	79.9	78.3	7.61	13.0	0.005
	Hip (cm)	94.7	92.9	5.77	7.82	0.028
	Proximal (cm)	56.6	56.5	4.55	4.68	0.001
	Mid-thigh (cm)	49.6	52.2	10.5	5.25	<0.001
	Leg (cm)	36.4	35.9	3.93	2.90	<0.001
	Ankle (cm)	22.0	22.0	1.35	1.55	0.671
Bone lengths	Acromiale radiale (cm)	32.9	33.1	2.45	2.22	0.004
	radiale-stylion (cm)	24.7	24.6	1.47	1.40	0.040
	Midstylion-dactylion (cm)	18.9	19.0	0.81	1.15	0.924
	Iliospinale (cm)	94.3	98.2	10.6	7.00	<0.001
	Trochanterion (cm)	89.4	90.5	7.85	5.65	<0.001
	Trochanterion-tibiale laterale (cm)	43.8	44.3	2.73	3.48	0.103
	Tibiale laterale to floor (cm)	46.1	46.3	2.72	4.50	0.592
	Foot length (cm)	26.0	26.2	0.94	1.05	0.195
	Tibiale mediale-sphyrion tibiale (cm)	38.1	38.1	2.35	2.45	0.969
Bone diameters	Biacromial (cm)	34.7	34.9	2.89	2.85	0.008
	Anteroposterior abdominal (cm)	16.7	16.6	3.19	5.58	0.082
	Bicristal breadth (cm)	23.1	23.3	3.38	3.35	0.002
	Transverse thorax (cm)	25.0	25.1	2.71	3.25	0.961
	Anteroposterior thorax (cm)	18.8	15.9	14.5	3.52	<0.001
	Humerus (cm)	9.76	6.80	15.9	0.50	<0.001
	Bi-styloid (cm)	6.88	5.45	6.71	0.62	<0.001
	Femur (cm)	10.9	9.65	6.57	0.65	<0.001
	Bimalleolar (cm)	7.26	7.25	0.42	0.50	0.676

SD: standard deviation; IQR: interquartile range.
* A *p*-value<0.05 (Shapiro Wilk) means that the data do not show a normal distribution, so median values are accepted.

Table 2. Anthropometric and body composition indicators in the sample (n=28).

Indicators		Mean	Median	SD	IQR	*p*-value *
Body mass index kg/m²		23.2	22.9	3.12	3.87	0.025
Waist–hip ratio		0.84	0.83	0.06	0.08	0.282
Sum of six skin folds (mm)		78.8	72.5	31.4	46.5	0.093
Sum of eight skin folds (mm)		105	93.0	41.9	67.9	0.123
Body composition	% adiposity	29.9	30.2	8.86	10.9	0.131
	% muscle	42.9	44.7	9.39	10.6	0.010
	% bone	10.2	8.65	7.41	1.60	<0.001
	% residual	10.6	10.4	1.74	1.82	0.304
	% skin	5.70	5.65	0.92	1.05	0.024
Somatotype	Endomorph	3.41	3.30	1.26	2.35	0.080
	Mesomorph	4.77	5.00	1.44	1.95	0.479
	Ectomorph	2.42	2.60	1.28	1.90	0.314

SD: standard deviation; IQR: interquartile range.
* A *p*-value<0.05 (Shapiro Wilk) means that the data do not show a normal distribution, so median values are accepted.
Source: Own elaboration.

Furthermore, it was found that the mean body mass was higher in midfielders (72.4±9.25kg) (Table 3), although there were no statistically significant differences with respect to the other playing positions (p=0.077). The average values for height, sitting height, and arm span were higher in goalkeepers (179±1.91cm, 92.9±2.07cm, and 180±3.38cm, respectively) (Table 3), but a significant difference was found only in height compared to the other positions (Table 4) (p<0.001).

Regarding the mean values of the sum of six skin folds, the sum of eight skin folds, waist–hip ratio and BMI, it was found that they were higher in midfielders (92.2±33.6mm, 125±48.6mm, 0.87±0.04cm, and 25.4±3.26kg/m², respectively). However, no statistically significant differences were noted in these anthropometric indicators compared to the other playing positions (p>0.05) (Table 4).

On the other hand, regarding body composition percentages, it was found that the mean percentage of adiposity was higher in goalkeepers (35.1±12.9%), the mean percentage of muscle mass was higher in midfielders (47.1±6.5%), the mean percentage of bone mass was higher in defenders (12.3±11.1%), and the mean percentage of skin was higher in goalkeepers (6.20±0.47%). However, these differences were not statistically significant compared to the other playing positions (p>0.05). The anthropometric indicators and body composition percentages of the soccer players based on their playing position are described in Table 4.

Table 3. Basic anthropometric measurements by type of playing position of the sample (n=28).

Measurements	Defense (n=12)					Forward (n=7)					Midfielder (n=5)					Goalkeeper (n=4)				
	Mean	Median	SD	IQR	*p*-value *	Mean	Median	SD	IQR	*p*-value *	Mean	Median	SD	IQR	*p*-value *	Mean	Median	SD	IQR	*p*-value *
Age (years)	22.3	20.7	4.95	2.97	0.001	31.9	32.5	4.55	3.32	0.183	22.7	22.7	1.79	2.28	0.963	23.2	23.2	2.68	2,14	0.916
Body mass (kg)	66.9	65.5	10.9	10.6	0.010	69.8	71.3	5.08	4.65	0.588	72.4	75.2	9.25	8.20	0.766	68.6	68.3	5.67	8.42	0.432
Height (cm)	172	174	5.68	6.05	0.404	172	172	4.31	3.85	0.757	169	168	2.62	2.10	0.396	179	179	1.91	2.97	0.251
Sitting height (cm)	90.0	90.3	3.01	4.82	0.467	90.0	91.0	2.77	4.70	0.231	89.7	90.0	3.38	2.20	0.082	92.9	93.1	2.07	2.52	0.830
Arm span (cm)	173	172	5.77	6.08	0.645	172	173	6.64	8.00	0.809	173	173	4.11	3.20	0.947	180	179	3.38	3.97	0.914

SD: standard deviation; IQR: interquartile range.
* A *p*-value<0.05 (Shapiro Wilk) means that the data do not show a normal distribution, so median values are accepted.

Table 4. Anthropometric indicators and body composition percentages by playing position of the sample (n=28).

	Defense (n=12)					Forward (n=7)					Midfielder (n=5)					Goalkeeper (n=4)				
	Mean	Median	SD	IQR	*p*-value *	Mean	Median	SD	IQR	*p*-value *	Mean	Median	SD	IQR	*p*-value *	Mean	Median	SD	IQR	*p*-value *
Body mass index Kg/m²	22.6	20.9	3.66	2.97	0.006	23.7	24.3	1.83	2.25	0.789	25.4	25.1	3.26	3.80	0.900	21.5	21.8	1.73	2.52	0.248
Waist–hip ratio	0.84	0.83	0.07	0.08	0.913	0.85	0.83	0.08	0.07	0.076	0.87	0.89	0.04	0.04	0.814	0.80	0.80	0.03	0.03	1.000
Six skin folds (mm)	79.9	70.0	33.2	60.1	0.101	66.8	65.1	23.3	29.1	0.608	92.2	99.0	33.6	36.7	0.954	79.8	78.5	39.9	32.5	0.921
Eight skin folds (mm)	105	92.0	43.1	76.6	0.152	92.0	87.1	33.7	40.3	0.443	125	137	48.6	53.7	0.925	104	106	50.4	47.9	0.986
% adiposity	30.6	32.0	10.4	13.9	0.975	26.4	26.2	3.48	4.45	0.953	29.0	30.4	6.29	5.30	0.927	35.1	33.3	12.9	9.63	0.704
% muscle mass	40.6	42.7	9.26	12.4	0.538	45.8	49.9	9.04	7.20	0.011	47.1	45.2	6.50	7.80	0.791	38.9	43.6	12.9	10.4	0.139
% bone mass	12.3	8.65	11.1	2.85	<0.001	8.31	8.7	1.42	0.85	0.176	8.28	8.10	1.03	0.70	0.846	9.33	9.35	1.84	2.57	0.657
% residual	10.7	10.6	2.28	2.90	0.99	10.9	10.7	1.51	1.80	0.368	10.3	10.4	0.70	0.50	0.307	10.4	9.85	1.53	1.50	0.162
% skin	5.70	5.80	1.26	1.25	0.191	5.73	5.7	0.45	0.55	0.662	5.26	5.00	0.59	0.60	0.642	6.20	6.25	0.47	0.50	0.925

SD: standard deviation; IQR: interquartile range.
* A *p*-value<0.05 (Shapiro Wilk) means that the data do not show a normal distribution, so median values are accepted.

Likewise, no significant differences were observed in any of the anthropometric indicators and body composition percentages between playing positions (Table 5).

Table 5. Statistical differences in anthropometric indicators and body composition percentages among players according to playing position.

Anthropometric indicators		***p*-value**
BMI		0.08 *
Waist–hip ratio		0.11 †
Sum of six skin folds		0.57 †
Sum of eight skin folds		0.67 †
Percentage of body composition	% adiposity	0.43 †
	% muscle	0.32 *
	% bone	0.46 *
	% residual	0.81 †
	% skin	0.16 †

* Differences between medians (Kruskal-Wallis test).
† Differences between means (ANOVA).

Regarding somatotype (mesomorphic, ectomorphic, and endomorphic), no statistically significant differences were observed between the medians recorded for the players by playing position ($p<0.05$). The mesomorphic biotype was the most frequent in all positions, with midfielders and forwards having the highest medians: 5.62 and 5.59, respectively. The endomorphic biotype showed medians with moderate values (between 2.94 and 4.12) in all positions, being higher in midfielders (4.12) (Figure 2).

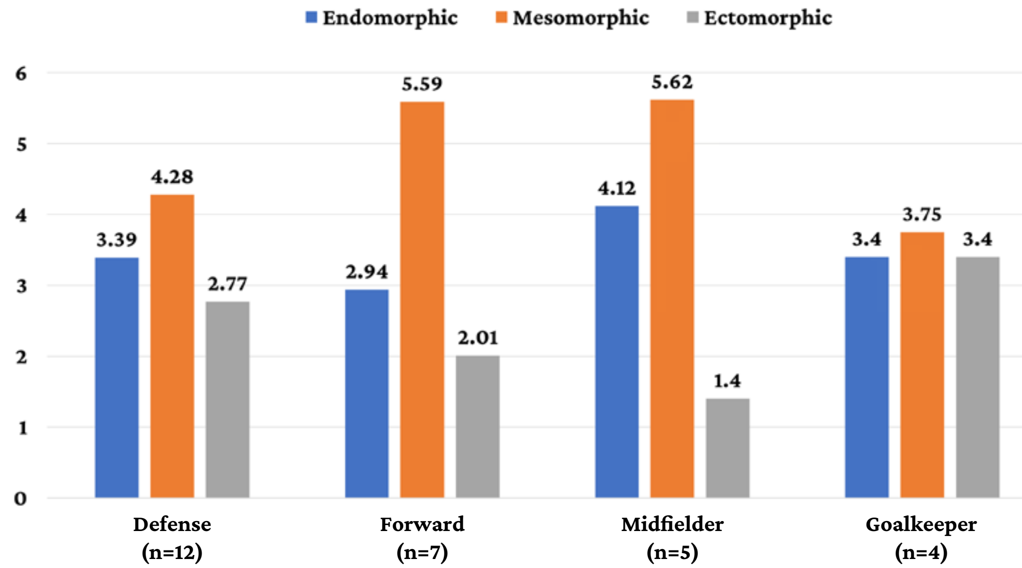

Figure 1. Values (medians) of the somatotype in relation to the playing position of the participants (n=28). Note: The data did not show a normal distribution ($p<0.05$, Shapiro-Wilk test), so the values in this figure are expressed as medians.

Regarding somatotype classification, 35.71% of the soccer players had an endo-mesomorphic composition, showing a statistically significant difference between the presence of this composition and the other somatotype. ($p=0.02$). In addition, this composition was the most frequent in forwards (4 out of 7 players) and midfielders (3 out of 5 players); however, these differences were not statistically significant compared to the other positions ($p=0.56$). The second most common somatotype was ecto-mesomorphic (17.85%), being more frequent in defenders (3 of 12 players). The results of the distribution of somatotypes by playing position are presented in Table 6.

Table 6. Classification of somatotype categories by playing position of the sample (n=28).

Somatotype	Playing position			
	Defense (12)	Forward (7)	Midfielder (5)	Goalkeeper(4)
Mesomorph-ectomorph	1	0	0	1
Balanced ectomorph	1	0	0	0
Meso-ectomorph	1	0	0	1
Meso-endomorph	1	0	1	1
Ecto-endomorph	1	0	0	0
Mesomorph-endomorph	2	0	0	0
Balanced mesomorph	0	1	1	0
Ecto-mesomorph	3	2	0	0
Endo-mesomorph	2	4	3	1

The distribution of somatotypes was considerably heterogeneous in the sample, with the heterogeneity being more evident in the defenders. Also, greater homogeneity was observed in midfielders (predominance of the mesomorphic-endomorphic somatotype) and forwards (predominance of the mesomorphic component). The somatotype charts for the whole sample and for each playing position are presented below (Figure 2).

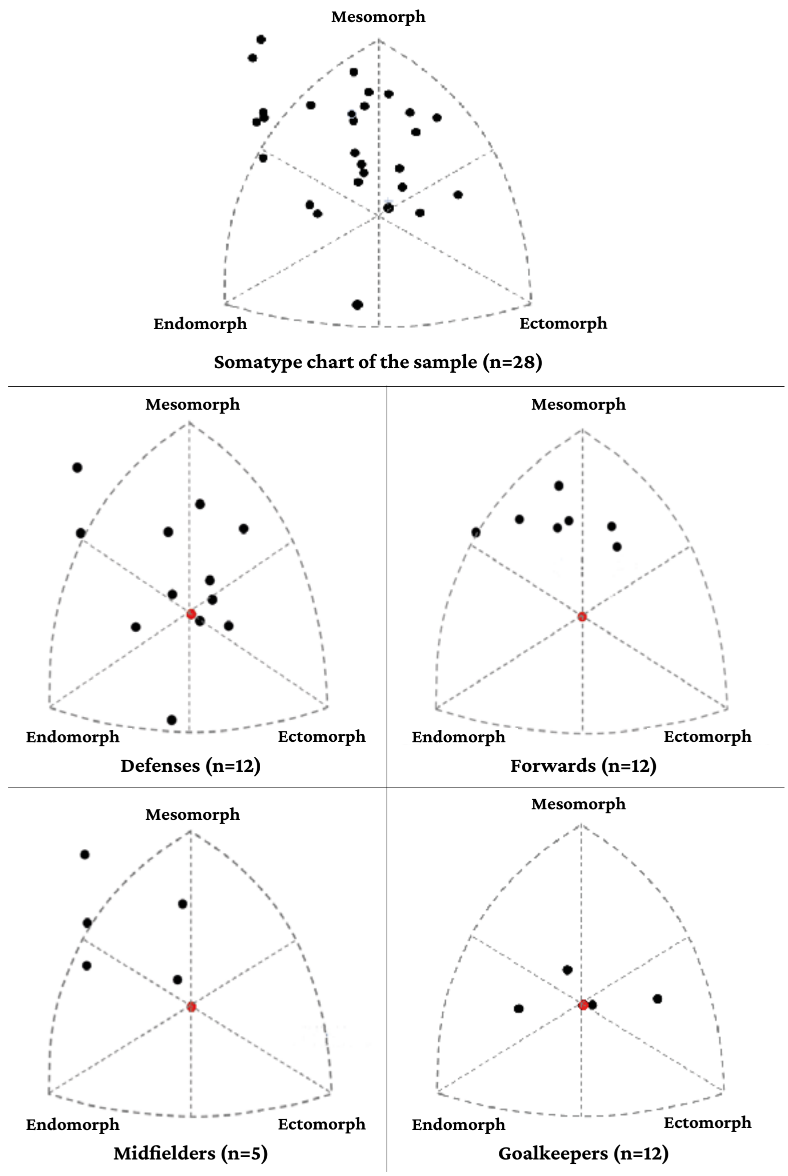

Figure 2. Somatotype chart of the sample and by playing position (n=28).

Discussion

This study presents anthropometric and body composition profiles of soccer players of a professional team based on the five-way fractionation method, differentiating them by playing positions (goalkeepers, midfielders, defenders, and forwards) and using the complete profile determined according to the ISAK protocols.[13]

There are few studies evaluating body composition and somatotype in professional soccer players using the complete profile determined based on the ISAK protocols.[3,14,15] In addition, although some report anthropometric profile data in this population, they use three- or four-component models of body composition.[16-18] On the other hand, some studies compare body composition with physical performance[6,10] or with the dietary patterns or nutritional supplementation of each player.[19,20] Similarly, there are studies that have made anthropometric comparisons in adolescent soccer players by age range (14 to 18 years)[15] and others that have focused on comparisons between players from different clubs.[2,6,17] However, a common feature of most of these studies is that they consider the playing position in their analyses.[6,14-18]

The mean age of the soccer players included in the present study was 24.9 years. This finding is similar to what has been reported in Chile by Hernández-Jaña *et al.*,[2] who, in a study conducted on 111 players of the different categories of the Chilean national soccer team (U-15: n=27, U-17: n=32, U-20: n=27, and professional: n=25), found that the mean age of the professionals was 24.3 years. This is also similar to what was described by Rodríguez-Rodríguez *et al.* [14] in a study of 390 professional soccer players from 15 professional clubs in Chile, who had a mean age of 24.77 years.

In the present study, the mean BMI values in the soccer players were between 21.5kg/m² and 25.4kg/m², with 23.2kg/m² being the mean BMI for the entire sample. These results are also consistent with those reported in Chile since the mean BMI values varied between 23.7kg/m² and 25.1 kg/m² in the study by Hernández-Jaña *et al.*[2] and between 24.0kg/m² and 24.8kg/m² in the study by Rodríguez-Rodríguez *et al.*[14].

Nonetheless, it should be noted that the average BMI values reported in the present study are higher than those described in several studies of soccer players, but it must be pointed out that the participants in those studies were younger than the average professional soccer player: 2.29kg/m² for U-16 players,[15] 21.9kg/m² for U-17 players,[17] and 22.33kg/m² for players between 14 and 18 years of age[16] Likewise, studies have been carried out in players between 10 and 13 years of age where the mean BMI values vary between 17.3kg/m² and 19.3kg/m².[21]

It should be kept in mind that different parameters are used to interpret BMI in children under 18 years of age, with findings from some of these studies indicating that the aforementioned differences may be related to growth; in other words, these players may have lower weight, height, and BMI due to their younger age.[16,21] Therefore, the BMI values reported in the present study are in accordance with the age and category (professional) of the participants in accordance with the data reported in studies carried out in similar populations[2,14] and, consequently, are useful as a reference for making tactical decisions in teams in the country.

Concerning body mass and BMI by playing position, the highest mean values in the present study were observed in midfielders (72.4kg and 25.4kg/m², respectively), a finding that differs from what has been reported in several studies, in which goalkeepers have a higher weight and BMI.[2,14,18,21] On the contrary, the mean height in midfielders was the lowest in comparison with the other three playing positions, which is consistent with what was reported in those same studies.[2,14,18,21] On this matter, some research has established that height has an impact on the position of the player, so taller players usually play in goalkeeper or defense positions in order to be more successful in the possession of the ball in aerial plays.[10,14]

The mean percentage of adiposity in our sample (29.9%) was higher than that reported by Duarte-Cornejo[15] in a study conducted to determine the anthropometric profile and morphological characteristics of 22 Chilean U-16 soccer players using the five-way method, reporting a mean percentage of adiposity of 26.34%.

In soccer, it has been described that low adiposity values are desirable for optimal performance and favor the agility of athletes.[5,7,22] However, this is not the case in defense positions, since physical activity is less intense and energy expenditure is lower in these players.[6,7] Therefore, defenders may have a slightly higher percentage of adiposity, which also helps them to better endure collisions with other players and prevent opponents from getting close to the goal and scoring. In the specific case of the participants in the present study, high adipose mass percentages could be a disadvantage given that excess adipose tissue has been reported to reduce performance and increase energy demand, as it acts as dead weight in activities during which body mass must be lifted against gravity, such as locomotion and jumping.[23]

Unlike the percentage of adiposity, the mean muscle percentage found in the present study (42.9%) is lower than the one described in the literature, where values between 45.5% and 58.6% have been reported.[2,4,15,21] However, it should be noted that Rodriguez-Rodriguez *et al.*[14] reported a lower mean percentage of muscle mass: 38.3% for the entire sample and mean percentages depending on the playing positions between 35.8% and 40.7%.

The percentage of muscle mass is important for good performance on the playing field as it is related to the ability to accelerate at close range. This is a relevant matter for soccer players, sincec it has been described that 96% of sprints in a match occur at distances of less than 30 meters and that 49% of them occur at distances of less than 10 meters.[10,14,24] However, muscle mass should not be increased much as this could affect weight and thus lead to poor athletic performance.[14]

About the percentage of adipose mass depending on the playing position, in the present study, it was found that goalkeepers had the highest mean (35.1%). A similar finding was reported by Rodriguez-Rodriguez *et al.*,[14] who demonstrated that adipose mass was higher in goalkeepers (mean: 18.0±2.1kg), with statistically significant differences compared to the other positions ($p<0.001$). This may be related to the fact that goalkeepers are subject to a lower metabolic load than other players during matches and training since, for example, it has been reported that goalkeepers run about 4km during a match, while midfielders run between 11km and 11.5km.[3]

Meanwhile, in the present study, midfielders had the highest mean percentage of muscle mass (47.1%), followed by forwards (45.8%), which differs from the results reported by Duarte-Cornejo,[18] who found that forwards had the highest percentage of muscle mass (47.49%) and midfielders had the lowest (42.32%). On this regard, it has been described that having a high percentage of muscle mass is beneficial for the performance of soccer players, especially when the musculature is located in greater proportion in the lower extremities, since this allows them to better meet the needs of their playing position.[2,14]

In the present study, the endo-mesomorph somatotype was the most common (35.71%), meaning that the mesomorph component predominated, followed by the endomorph. This finding was more frequent in forwards and midfielders, although no statistically significant differences were observed in the frequency of this somatotype among playing positions ($p>0.05$). When analyzing other studies carried out in professional soccer players, a similar behavior can be observed, since the mesomorphic component has been reported as predominant in both Colombian[17,18,25] and international studies.[14,16,24,26] This finding could be explained by the fact that this muscle composition favors the performance of players during matches in actions such as attacking, pressuring the opponent, accelerating, kicking the ball, and possessing the ball.[16]

Although the sample of the present study was not extensive, this research is an overview of the anthropometric characteristics, body composition and somatotype of professional male soccer players in Colombia and can be considered a reference for future comparative or intervention studies, like the study by Erazo *et al.*,[25] which was carried out in 22 soccer players from a U-20 sports club in Bogotá. However, we suggest that further studies should be carried out with larger samples and that, if possible, comparisons should be made with players from other professional categories and other soccer clubs. Moreover, dietary patterns should be considered since they may have an impact on anthropometric characteristics; accordingly, the articulation between these two issues may be relevant to generate strategies to improve sports performance.

The main limitation of the present study is its relatively small sample size. Another limitation is that comparisons were only made among participants based on their playing position and not with players from other professional soccer teams in the country (either in the same category or a different one), presenting a challenge for new studies to take these factors into account.

Conclusions

The findings of the present study allowed us to demonstrate anthropometric and somatotype differences in relation to playing positions in a Colombian professional soccer team (third division). Knowing these differences will allow the coaching staffs of the region's soccer clubs to establish short- and long-term training and sport performance goals according to each player's position.

Since this is the first local study on this subject, the findings of this research may be used as a starting point to establish physical preparation plans that aim to improve the performance of professional soccer players from clubs in the region. Similarly, based on these data, the management team of the soccer club to which the players who participated in this study belong can adjust training plans according to anthropometric and body composition differences between playing positions.

Conflicts of interest

None stated by the authors.

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