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Anthropometric Characteristics, Body Composition, and Somatotype by Position in Professional Ecuadoran Soccer Players

[*Características antropométricas, composición corporal y somatotipo por posiciones de juego en futbolistas profesionales ecuatorianos*]

[*Características antropométricas, composição corporal e somatótipo por posições de jogo em jogadores profissionais de futebol equatorianos*]

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ABSTRACT

Introduction: Soccer is a complex acyclic discipline, which is particularly demanding of very high physical aptitudes.
Aim: To determine the anthropometric characteristics, body composition, and somatotype to unveil the morphological profile of professional Ecuadoran soccer players, and compare them according to the game positions.
Materials and methods: An observational-descriptive study was conducted. A number of 73 Ecuadoran professional soccer players were evaluated, including seven goalkeepers, 25 defenders, 29 wingers, and 12 attackers. The international ISAK protocol was performed for measurements, with optimally calibrated equipment. An ANOVA was performed to describe the information, and a Student-T test was conducted to verify the significant differences ($p<0.05$) by game position.
Results: Significant differences ($p<0.05$) were observed among the different game positions, especially between the goalkeepers and the other players. Compared to the international players, the Ecuadorans differed in terms of basic measurements and

muscle mass. The other variables were similar. **Conclusions**: The anthropometric characteristics, body composition, and somatotype of professional Ecuadoran soccer players by position and overall average were determined. There were significant differences among the variables studied by game position. The Ecuadoran soccer players have different basic metrics from the group of international players, with lower muscle mass. Concerning fat, sum of 6 skinfold thickness, muscle-bone index, and somatotype, the similarities were remarkable.

Keywords: Anthropometric variables, body composition, somatotype, soccer.

RESUMEN

Introducción: El fútbol como una disciplina acíclica compleja y particularmente exigente, demanda de aptitudes físicas muy altas. **Objetivo:** Determinar las características antropométricas, composición corporal y somatotipo para revelar el perfil morfológico de los futbolistas profesionales ecuatorianos y compararlos según las posiciones de juego. **Material y método:** Se efectuó un estudio observacional descriptivo. Se evaluaron 73 futbolistas profesionales ecuatorianos: siete arqueros, 25 defensas, 29 volantes y 12 delanteros. Para las respectivas mediciones se aplicó el protocolo internacional ISAK y se usó equipos completamente calibrados. Se empleó una prueba Anova para la descripción de la información y una prueba de T de student para verificar las diferencias significativas ($p<0.05$) por posiciones juego. **Resultados:** Se evidenciaron diferencias significativas ($p<0.05$) entre las posiciones de juego, concretamente entre los porteros y el resto de jugadores. Frente a los jugadores internacionales, los futbolistas ecuatorianos difieren en medidas básicas y masa muscular. Con respecto al resto de variables existe mucha similitud. **Conclusiones:** Se detallaron las características antropométricas, composición corporal y somatotitpo de los futbolistas ecuatorianos por posiciones de juego y promedio total. Si existen diferencias significativas en las distintas variables estudiadas por posiciones de juego. El futbolista ecuatoriano difiere en medidas básicas con respecto a los grupos internacionales, presentan menor masa muscular y en relación a la masa grasa, sumatoria de seis pliegues, índice musculo hueso y somatotipo existe una similitud muy marcada.

Palabras clave: Variables antropométricas, composición corporal, somatotipo, fútbol.

SÍNTESE

Introdução: O futebol como uma disciplina acíclica complexa e particularmente exigente exige aptidões físicas muito elevadas. Objetivo: Determinar as características antropométricas, composição corporal e somatótipo para revelar o perfil morfológico dos jogadores profissionais de futebol equatorianos e compará-los de acordo com as posições de jogo. **Método**: Foi realizado um estudo observacional descritivo. Foram avaliados 73 jogadores de futebol profissional equatorianos: sete goleiros, 25 defensores, 29 meio-campistas e 12 atacantes. Para as respectivas medidas, foi aplicado o protocolo

internacional ISAK e foi utilizado equipamento totalmente calibrado. Um teste Anova foi usado para descrever as informações e um teste t de Student foi usado para verificar as diferenças significativas ($p<0,05$) por posições de jogo. **Resultados**: Foram encontradas diferenças significativas ($p<0,05$) entre as posições de jogo, especificamente entre os goleiros e o resto dos jogadores. Em comparação com os jogadores internacionais, os jogadores equatorianos diferiram nas medidas básicas e na massa muscular. Com relação ao resto das variáveis, há muitas semelhanças. **Conclusões**: As características antropométricas, a composição corporal e o somatótipo dos jogadores de futebol equatorianos foram detalhados por posições de jogo e média total. Existem diferenças significativas nas diferentes variáveis estudadas pelas posições de jogo. O jogador de futebol equatoriano difere nas medidas básicas em relação aos grupos internacionais, apresenta menos massa muscular e em relação à massa gorda, soma de seis dobras, índice músculo-osso e somatótipo há uma semelhança muito marcada.

Palavras-chave: Variáveis antropométricas, composição corporal, somatótipo, futebol.

INTRODUCTION

Soccer is a complex acyclic discipline, which is particularly demanding of very high physical aptitudes. Its intermittent characteristics, recurrent sprints and high endurance capacity demand energy requirements both anaerobic and aerobic (Ranchordas *et al.*, 2017).

Professional soccer players can run between 10 and 13 km (8-9 km at a moderate and low intensity, and 1.5-2.5 km with a high intensity). Around 1000-1400 actions can be performed (movement variation every 5-6 sec), while they take approximately 220 high-speed races for 90 min, regardless of the overtime period. Besides, it has been estimated that 90 min account for 1195-1700 kcal, though it can vary depending on the position of the game and the distances run. Soccer players with daily training sessions may experience 3439-3822 kcal a day (Bonnicci *et al.,* 2018).

To achieve competitive success in this discipline, it is important to know and understand the requirements of the sport in the high-performance athletes. Fortunately, there are well-documented evaluation methods that can provide detailed information about the athletes. The anthropocentric measurements, and the physiological and physical capacities, including cardiorespiratory endurance, muscle strength, muscular endurance, and flexibility, which are commonly performed to identify the morphology, physiology, and physical capacities of the professional soccer players (Slimani & Nikolaidis, 2017). Additionally, all that information could help coaches and athletes analyze the characteristics of the players objectively, and to report talent detection and training during the sports starter stages in the discipline (Nughes *et al.*, 2020; Randell *et al.*, 2021).

The analysis of the morphological characteristics of athletes permits the diagnostic of their current body configuration, which will be used to implement nutritional and training strategies, depending on the approach assumed, to enhance performance, and

reduce the risk of injuries, thus increasing the possibilities of success on the team (Leao *et al.,* 2019).

Sports talent search demands a complex interaction of multifactorial performance characteristics that not only include physiological, technical, tactical, psychological, and sociological influences, but also morphological ones. In other words, it is the selection of athletes based on their morphological structure. For instance, height (greater reach), muscle mass (greater strength and power), lower fat (less weight and more energy saving) (Larkin *et al.,* 2021).

These parameters provide a significant help with the proper intervention focused on morphological improvements, according to the specificities of the sports discipline and the game positions.

The popularity of soccer worldwide has aroused great interest in the research of several science fields. The tendency of anthropometric studies in soccer has increased in the last decade. However, there are few reports of anthropometric characteristics, body composition, and specific somatotypes for the sport in Latin America, depending on the game positions, especially in Ecuador.

Therefore, the aim of this research is to determine the anthropometric characteristics, body composition, and somatotype to unveil the morphological profile of professional Ecuadoran soccer players, and compare them according to the game positions.

MATERIALS AND METHODS

Participants

This is an observational-descriptive study, which evaluated 73 first-division professional soccer players with an average age of 23, which focused on their positions in the game. The study was organized as follows: seven goalkeepers, 25 defenders, 29 wingers, and 12 attackers.

Materials

The evaluations were performed using a Rosscraft anthropometric kit made in Argentina. The height and seated height were measured using a paper height meter on the wall, measuring between 60 and 220 cm, and 0.1 cm accuracy. The weight was measured using a bio impedance digital scale (Inbody 120), with a minimum accuracy of 50 grams, and completely calibrated. Concerning the perimeters, the measures were made using an anthropometric stainless steel measure tape (Lufking), no greater than 7 mm wide, and a null area of 4 cm prior to the zero line, with a minimum length of 1.5 meters, and 0.1 cm appreciation.

The large bone diameters were evaluated using a caliper (Campbell 20), with L branches coupled to a rigid scale, approximately 60 cm long, and 0.1 cm accuracy. The small bone diameters were measured with a caliper (Campbell 10), 15 cm minimum scale, 10 cm

long branches, and 1 mm accuracy. The skinfold thickness was measured using a fat caliper (Gaucho Pro) with constant pressure, calibrated to 90 mm, with 1 mm divisions. Besides, an anthropometric case (50 cm long, 40 cm high, and 30 cm deep) was used for certain measurements.

Anthropometric procedures

The anthropometric evaluations were based on the requirements by the *Society for the Advancement of Kineatropometry* (ISAK, 2019).

The evaluations were made before the training sessions, in the early hours. Each athlete was informed about the procedure, and signed a written consent authorizing the evaluations. To facilitate the anatomical reference scoring, the athletes were asked to wear light clothes.

According to the ISAK protocol, each subject was evaluated on their right side, regardless of their laterality. Overall, 25 anthropometric measurements were taken.

- Basic measurements: weight, height, and seated height. The weight was measured with the subject standing on the scale, wearing light clothes. Height measurements were based on moderate traction upward on the mastoids, with a previous placement of the head on the Frankfort plane.
- Bone diameters: biacromial, transverse thoracic plane, anteroposterior thorax, bi-iliac, humeral, and femoral.
- The diameters were measured by placing the caliper on the back of the hands, with the thumbs placed on the inner sides of the branches, the indexes extended inside, and the fingers almost palpating the bone marks to locate the caliper branches, and perform the readouts.
- Perimeter: head, relaxed arm, flexed and tense arm, maximum forearm, mesosternal thorax, waist, hip, maximum thigh, mid-thigh, and calf.

To measure the perimeters, the tape case was always in the right hand, whereas the other end was held with the index and thumb of the left hand. When the measure tape was placed around the perimeter, it was measured with the naked eye at the height of the tape, facing the zero mark to avoid errors.

Skinfold thickness: triceps, subscapularis, supraspinal, abdominal, mid-thigh, and calf.

To measure the skinfold thickness, the index and thumb of the left hand next to the anthropometric mark grasped the double layer of fat and skin, and then the fat caliper was used at 1 cm from the mark at 90 degrees, and at the same depth of the skinfold thickness. With the fold held, the values were read two seconds after applying the fat caliper pressure. Then it was withdrawn and the fold was released.

The data were recorded on an anthropometric form, by a trained assistant.

All the measurements were processed and analyzed in an Excel spreadsheet to determine the fractioning of the body composition, into five components (Kerr, 1988),

body proportionality through the body indexes and somatotype (Carter and Heath, 1990) of every athlete.

Descriptive statistics was used to determine the means, standard deviations, minimums and maximums by ANOVA, and a Student-T test, to determine the significant differences between the different game positions.

RESULTS

Table 1 shows the means and standard deviations of every anthropometric measurement according to the positions of the game. Besides, it shows that $p<0.05$, resulting from the ANOVA test of the four positions of the game.

In terms of age, the goalkeepers had the lowest average compared to the rest of players, with no significant differences among the four positions of the game. The goalkeepers showed the greatest weight and height, with a significant difference from the other players. The attackers showed the highest average in the maximum thigh, mid-thigh, and calf perimeters, a significant difference from the other players.

Table 2 shows the means and standard deviations of body composition, body indexes, and somatotypes according to the positions of the game. Besides, it shows $p<0.05$, resulting from the ANOVA test of the four positions of the game.

In terms of body composition, the wingers showed less adipose mass than the goalkeepers, defenders, and attackers. However, the four positions of the game did not differ significantly, and their fat masses were acceptable, according to the Argentinian references (ARGOREF, 2013). The attackers showed the highest average in the muscle mass, a significant difference from the other players. According to the ARGOREF references, all the groups had acceptable muscle mass.

The highest average of bone mass was observed in the goalkeepers, with no significant differences from the other players. Likewise, the goalkeepers averaged the sum of 6 skinfolds less, and did not differ significantly from the other players.

Concerning the indexes, the wingers showed the highest average of the muscle/bone coefficient, with no significant differences from the other players. Meanwhile, the skeletal average was higher in the goalkeepers, with a significant difference from the other groups (Table 1, Table 2, Table 3 and Table 4).

Table 1. *- Means, SD, and min-max of the anthropometric measurements by game position, and total of Ecuadoran players*

	VARIABLES	GOALKEEPERS		DEFENDERS		WINGERS		ATTACKERS		TOTAL		*P VALUE
		Mean ± SD	Min - Max	Mean ± SD	Min - Max	Mean ± SD	Min - Max	Mean ± SD	Min - Max	Mean ± SD	Min - Max	
BASIC	Age (years)	21.5 ± 4.4	16.7 - 27.3	22.3 ± 5.1	16.7 - 35.9	22.3 ± 4.4	16.9 - 30.0	23.1 ± 6.4	16.0 - 33.7	22.4 ± 4.9	16.0 - 35.9	0.920
	Weight (kg)	76.3 ± 8.8	65.7 - 89.6	72.5 ± 7.0	58.4 - 87.8	69.7 ± 6.36	55.0 - 84	76.4 ± 4.3	71.7 - 86.4	73.7 ± 3.3	55.0 - 89.6	**0.012**
	Height (cm)	183.9 ± 3.4	181.5 - 191.0	175.3 ± 6.6	160.1 - 186.8	173.1 ± 5.2	162.5 - 186.0	176.2 ± 4.8	169.0 - 184.1	175.4 ± 6.2	160.1 - 191.0	**0.0001**
	Seated height (cm)	95.0 ± 3.0	90.0 - 99.0	91.5 ± 4.5	82.2 - 99.2	91.2 ± 3.6	80.5 - 97.8	92.7 ± 3.3	88.0 - 97.5	91.9 ± 3.9	80.5 - 99.2	0.104
DIAMETERS (cm)	Biacromial	42.5 ± 2.3	38.5 - 45.8	40.6 ± 2.0	35.3 - 43.9	40.3 ± 1.9	36.0 - 45.5	40.4 ± 1.9	37.5 - 43.4	40.6 ± 2.0	35.3 - 45.8	0.067
	Transverse thorax	29.0 ± 2.1	26.7 - 31.7	28.3 ± 2.2	25.0 - 32.9	28.2 ± 1.5	24.5 - 31.0	28.6 ± 1.8	25.5 - 31.5	28.4 ± 1.9	24.5 - 32.9	0.749
	Anteroposterior thorax	19.5 ± 2.1	17.0 - 22.7	19.2 ± 4.1	14.7 - 37.7	19.0 ± 4.4	14.0 - 39.2	18.5 ± 1.6	16.0 - 21.9	19.0 ± 3.8	14.0 - 39.2	0.938
	Biliocrestidium	30.0 ± 5.7	25.4 - 42.3	26.9 ± 1.6	24.0 - 29.9	27.1 ± 1.5	24.0 - 29.8	27.2 ± 2.0	23.1 - 30.5	27.3 ± 2.4	23.1 - 42.3	**0.018**
	Humeral	7.1 ± 0.3	6.6 - 7.4	6.9 ± 0.4	6.1 - 8.0	6.9 ± 0.4	6.4 - 8.0	6.9 ± 0.3	6.3 - 7.3	6.9 ± 0.4	6.1 - 8.0	0.402
	Femoral	10.5 ± 1.3	9.5 - 13.0	9.8 ± 0.4	9.0 - 10.5	9.8 ± 0.4	9.0 - 10.7	9.9 ± 0.3	9.3 - 10.5	9.9 ± 0.5	9.0 - 13.0	**0.018**
PERIMETERS (cm)	Head	56.2 ± 1.0	54.9 - 57.4	55.5 ± 1.8	52.2 - 59.5	55.3 ± 1.5	52.5 - 58.9	56.0 ± 1.5	54.0 - 58.5	55.6 ± 1.6	52.2 - 59.5	0.414
	Relaxed arm	30.6 ± 2.2	28.7 - 34.2	30.5 ± 2.2	26.5 - 35.2	29.7 ± 2.4	25.0 - 34.0	31.1 ± 2.2	28.5 - 35.6	30.3 ± 2.3	25.0 - 35.6	0.236
	Tense flexed arm	32.8 ± 2.2	30.8 - 36.3	32.2 ± 2.0	28.0 - 35.8	31.3 ± 2.3	26.3 - 35.0	32.9 ± 2.1	29.5 - 36.9	32.0 ± 2.2	26.3 - 36.9	0.134
	Max forearm	27.9 ± 1.8	25.5 - 30.2	27.2 ± 1.4	24.9 - 30.3	26.5 ± 1.4	23.5 - 30.0	27.4 ± 1.2	26.3 - 30.2	27.0 ± 1.4	23.5 - 30.3	**0.037**
	Mesosternal thorax	96.1 ± 4.8	90.0 - 105.4	91.8 ± 4.5	83.0 - 98.5	92.1 ± 4.0	83.0 - 99.0	93.7 ± 4.8	87.3 - 101.8	92.6 ± 4.5	83.0 - 105.4	0.107
	Waist	79.0 ± 4.8	72.0 - 85.6	77.0 ± 4.0	71.0 - 86.5	78.0 ± 4.2	70.0 - 84.4	78.7 ± 3.1	72.5 - 83.0	77.9 ± 4.0	70.0 - 86.5	0.538
	Hip	95.6 ± 4.6	88.5 - 101.8	95.4 ± 4.8	86.5 - 107.0	94.5 ± 4.3	84.0 - 103.5	97.8 ± 3.0	94.0 - 106.0	95.5 ± 4.4	84.0 - 107.0	0.199
	Max thigh	56.7 ± 2.5	53.3 - 60.2	58.3 ± 3.2	53.0 - 64.5	56.9 ± 3.2	49.5 - 64.0	59.8 ± 2.5	57.0 - 66.0	57.8 ± 3.1	49.5 - 66.0	**0.026**
	Mid-thigh	52.9 ± 3.9	47.5 - 57.4	54.4 ± 3.1	48.0 - 60.5	53.0 ± 3.0	46.5 - 59.0	56.2 ± 2.7	52.0 - 62.0	54.0 ± 3.2	46.5 - 62.0	**0.014**
	Calf	36.1 ± 2.3	32.7 - 39.1	37.7 ± 2.0	34.0 - 42.3	36.0 ± 1.9	32.3 - 40.6	38.5 ± 1.9	35.5 - 42.3	37.0 ± 2.2	32.3 - 42.3	**0.001**
Folds (mm)	Triceps	7.0 ± 1.5	6.0 - 10.0	8.0 ± 3.3	4.0 - 16.0	6.8 ± 2.5	3.0 - 14.0	7.9 ± 4.6	3.0 - 17.0	7.4 ± 3.2	3.0 - 17.0	0.472
	Subscapular	9.4 ± 1.7	7.0 - 12.0	9.4 ± 1.9	5.5 - 13.5	9.3 ± 2.5	5.5 - 15.0	10.6 ± 1.8	7.0 - 14.0	9.5 ± 2.2	5.5 - 15.0	0.342
	Supraspinal	7.4 ± 2.7	4.0 - 12.0	8.8 ± 4.5	4.0 - 20.5	7.4 ± 3.2	3.0 - 17.0	7.7 ± 3.4	3.0 - 14.5	7.9 ± 3.7	3.0 - 20.5	0.555

	Abdominal	10.9 ± 3.5	5.0 - 16.5	14.3 ± 7.4	5.0 - 36.0	13.0 ± 6.4	5.0 - 31.0	14.4 ± 6.4	4.0 - 25.0	13.5 ± 6.5	4.0 - 36.0	0.615
	Mid-thigh	8.2 ± 2.2	4.0 - 11.0	8.9 ± 4.0	5.0 - 20.0	8.5 ± 3.0	4.5 - 15.0	8.8 ± 2.8	5.0 - 15.0	8.7 ± 3.3	4.0 - 20.0	0.951
	Calf	4.3 ± 1.8	2.0 - 7.0	4.8 ± 2.0	2.5 - 11.0	5.0 ± 1.6	2.5 - 9.5	4.9± 1.9	2.5 -8.5	4.8 ± 1.8	2.0 - 11.0	0.817

**P<0.05, by ANOVA.*

Table 2. - *Body composition, body indexes, and somatotype by game positions, and total of Ecuadoran players*

	VARIABLES	**GOALKEEPERS**		**DEFENDERS**		**WINGERS**		**ATTACKERS**		**TOTAL**		***P VALUE**
		Mean ± SD	**Min - Max**	**Mean ± SD**	**Min - Max**	**Mean ± SD**	**Min - Max**	**Mean ± SD**	**Min - Max**	**Mean ± SD**	**Min - Max**	
BODY COMPOSITION	**Fat mass (%)**	22.1 ± 3.1	16.4 - 25.1	22.4 ± 4.0	15.9 - 28.8	21.6 ± 3.2	17.0 - 31.5	22.1 ± 4.1	15.4 - 31.5	22.0 ± 3.6	15.4 - 31.5	0.897
	Fat mass (kg)	16.7 ± 1.8	14.1 - 18.5	16.1 ± 3.4	9.3 - 24.1	15.0 ± 3.0	10.7 - 22.8	16.8 ± 3.3	11.0 - 22.8	15.8 ± 3.1	9.3 - 24.1	0.249
	Muscle mass (%)	48.9 ± 3.1	44.0 - 53.8	49.9 ± 3.3	44.4 - 56.5	49.4 ± 2.7	42.9 - 54.5	50.9 ± 3.7	43.4 - 56.9	49.8 ± 3.1	42.9 - 56.9	0.442
	Muscle mass (%)	37.4 ± 6.3	30.3 - 46.2	35.9 ± 4.5	28.0 - 44.8	34.1 ± 4.1	25.1 - 42.1	38.8 ± 3.8	31.4 - 44.7	35.8 ± 4.7	25.1 - 46.2	**0.019**
	Muscle mass (%)	11.5 ± 1.2	9.6 - 13.0	10.9 ± 1.6	7.1 - 13.4	11.7 ± 1.4	9.1 - 16.0	10.6 ± 1.2	7.5 - 12.1	11.2 ± 1.5	7.1 - 16.0	0.076
	Residual mass (%)	8.8 ± 1.7	6.9 - 11.2	7.8 ± 1.4	5.9 - 10.7	8.0 ± 1.3	6.2 - 12.1	8.0 ± 0.9	6.0 - 9.3	8.0 ± 1.3	5.9 - 12.1	0.369
	Bone mass (%)	12.1 ± 1.0	11.0 - 14.1	11.4 ± 1.1	9.3 - 13.7	11.8 ± 1.0	10.0 - 13.4	11.0 ± 1.1	9.3 - 12.2	11.6 ± 1.1	9.3 - 14.1	0.076
	Bone mass (kg)	9.3 ± 0.9	7.7 - 10.5	8.8 ± 0.9	5.9 - 9.5	8.8 ± 0.8	7.3 - 10.2	8.7 ± 0.9	7.3 - 9.8	8.8 ± 0.9	5.9 - 10.5	0.507
	Skin mass (%)	5.4 ± 0.3	4.9 - 5.7	5.4 ± 0.4	4.5 - 6.1	5.5 ± 0.4	5.0 - 6.5	5.3 ± 0.3	4.6 - 5.7	5.4 ± 0.4	4.5 - 6.5	0.585
	Skin mass (kg)	4.1 ± 0.4	3.6 - 4.5	3.9 ± 0.3	3.4 - 4.3	3.8 ± 0.3	3.2 - 4.3	4.1 ± 0.2	3.7 - 4.5	3.9 ± 0.3	3.2 - 4.5	**0.004**
	Specific fat (%)	12.0 ± 0.8	10.6 - 12.8	12.1 ± 1.0	10.5 - 13.7	11.9 ± 0.8	10.8 - 14.3	12.0 ± 1.0	10.4 - 14.4	12.0 ± 0.9	10.4 - 14.4	0.897
	Specific fat (kg)	10.1 ± 1.5	7.5 - 11.8	9.9 ± 2.8	4.9 - 16.1	9.0 ± 2.4	6.2 - 16.3	10.3 ± 2.8	5.7 - 16.4	9.6 ± 2.6	4.9 - 16.4	0.428
	∑ 6 folds (mm)	47.2 ± 9.6	30.0 - 58.0	53.9 ± 19.9	27.0 - 99.0	48.5 ± 18.3	4.0 - 97.5	55.0 ± 18.5	27.0 - 91.5	51.3 ± 18.2	4.0 - 99.0	0.574
INDEXES	**M/B index**	4.0 ± 0.5	3.2 - 4.7	4.1 ± 0.6	3.0 - 5.6	3.9 ± 0.7	2.7 - 5.5	4.5 ± 0.7	3.3 - 5.8	4.1 ± 0.7	2.7 - 5.8	0.090
	Cormic index	51.7 ± 1.2	49.5 - 53.1	52.2 ± 1.3	49.7 - 55.0	52.7 ± 1.5	47.1 - 55.4	52.6 ± 2.1	50.3 - 56.2	52.4 ± 1.5	47.1 - 56.2	0.398

	Skeletal index	83.9 ± 3.4	81.5 - 91.0	75.3 ± 6.6	60.1 - 86.8	73.1 ± 5.2	62.5 - 86.0	76.2 ± 4.8	69.0 - 84.1	75.4 ± 6.2	60.1 - 91.0	**<0.001**
	M/A index	0.5 ± 0.1	0.3 - 0.6	0.5 ± 0.1	0.3 - 0.6	0.4 ± 0.1	0.3 - 0.7	0.4 ± 0.1	0.3 - 0.7	0.4 ± 0.1	0.3 - 0.7	0.955
SOMATOTYPE	**Endomorph**	2.1 ± 0.4	1.6 - 2.7	2.5 ± 1.0	1.2 - 4.3	2.4 ± 1.1	1.1 - 6.7	2.5 ± 1.0	1.4 - 4.3	2.4 ± 1.0	1.1 - 6.7	0.853
	Mesophorm	4.6 ± 1.1	3.2 - 6.4	5.2 ± 0.9	3.3 - 6.5	5.0 ± 1.0	2.5 - 7.2	5.5 ± 1.1	3.3 - 6.8	5.1 ± 1.0	2.5 - 7.2	0.230
	Ectomorph	3.2 ± 0.8	2.0 - 4.4	2.3 ± 0.8	1.1 - 3.8	2.3 ± 0.9	1.1 - 4.4	1.9 ± 0.7	0.8 - 3.0	2.3 ± 0.9	0.8 - 4.4	**0.011**

**P<0.05, by ANOVA.*

Table 3. *- P value of the anthropometric means by game positions of Ecuadoran players*

	VARIABLES	GOALK/DEF P value*	GOALK/WING P value*	GOALK/ATTF P value*	DEF/WING P value*	DEF/ATT P value*	WING/ATT P value*
BASIC	**Age (years)**	0.163	0.269	0.124	0.859	0.658	0.346
	WEIGHT	0.802	0.162	0.991	0.132	0.214	**0,031***
	Height (cm)	**0,008***	**0,002***	**0,047***	0.234	0.728	0.201
	Seated height (cm)	0.633	**0,035***	0.41	0.684	0.937	0.582
DIAMETERS (cm)	**Biacromial**	0.291	**0,015***	0.079	0.559	0.763	0.878
	Transverse thorax	0.384	0.964	0.786	0.919	0.684	0.34
	Anteroposterior thorax	0.824	0.707	0.468	0.911	0.274	0.13
	Bi-iliac	0.306	0.194	0.116	0.773	0.836	0.966
	Humeral	0.143	**0,045***	0.144	0.799	0.667	0.842
	Femoral	0.418	0.136	0.254	0.493	0.355	0.267
PERIMETERS (cm)	**Head**	0.807	0.094	0.443	0.78	0.058	0.644
	Relaxed arm	0.598	0.878	0.492	0.097	0.91	0.58
	Tense flexed arm	0.778	0.574	0.549	0.081	0.946	0.646
	Max forearm	0.776	0.195	0.453	**0,022***	0.645	0.096
	Mesosternal thorax	0.406	0.135	0.866	0.821	0.49	0.588
	Waist	0.975	0.948	0.921	0.454	0.624	0.341
	Hip	0.956	0.746	0.532	0.432	0.269	0.143
	Max thigh	0.378	0.307	0.08	0.07	0.301	0.115
	Mid-thigh	0.322	0.528	0.062	0.067	0.272	0.102
	Calf	0.304	0.958	**0,049***	**0,01***	0.271	0.063
Folds (mm)	**Triceps**	**0,035***	0.48	**0,045***	0.098	0.578	0.206
	Subscapular	0.469	0.389	0.564	0.851	**0,018***	0.436
	Supraspinal	0.511	0.131	0.419	0.153	0.923	0.157
	Abdominal	0.841	0.483	0.319	0.532	0.36	0.51
	Mid-thigh	**0,039***	0.161	0.478	0.677	0.226	0.942
	Calf	0.7	0.132	0.712	0.759	0.543	0.77

*P<0.05, by ANOVA.

Table 4. - *P value of the body composition, body indexes, and somatotypes by game positions of Ecuadoran players*

	VARIABLES	GOALK/DEF P value*	GOALK/WING P value*	GOALK/ATT P value*	DEF/WING P value*	DEF/ATT P value*	WING/ATT P value*
BODY COMPOSITION	Fat mass (%)	0.209	0.363	0.347	0.403	0.357	0.21
	Fat mass (kg)	0.129	**0,03***	0.443	0.199	0.261	0.052
	Muscle mass (%)	0.19	0.326	**0,044***	0.761	0.852	0.821
	Muscle mass (%)	0.742	0.558	0.282	0.145	0.273	0.126
	Residual mass (%)	0.514	0.9	0.366	**0,04***	0.061	**0,021***
	Residual mass (kg)	0.839	0.526	0.475	0.524	0.267	0.162
	Bone mass (%)	0.516	0.309	0.139	0.246	0.5	0.264
	Bone mass (kg)	0.26	**0,03***	0.094	0.633	0.534	0.146
	Skin mass (%)	0.889	0.911	0.631	0.429	0.621	0.793
	Skin mass (kg)	0.691	0.093	1	0.208	0.131	**0,009***
	Specific fat (%)	0.218	0.325	0.359	0.398	0.354	0.195
	Specific fat (kg)	0.123	**0.049**	0.398	0.235	0.296	0.072
	∑ 6 skinfolds (mm)	0.336	0.755	0.966	0.293	0.279	0.129
INDEXES	M/B index	0.139	0.288	**0,037***	0.394	0.791	0.718
	Cormic index	**0,037***	**0,008***	0.112	0.256	0.782	0.508
	Skeletal index	**0,008***	**0,002***	**0,047***	0.234	0.728	0.201
	M/A index	0.134	0.231	0.14	0.627	0.256	0.166
SOMATOTYPE	Endomorph	0.173	0.766	0.593	0.635	0.393	0.277
	Mesophorm	0.431	0.612	0.18	0.429	0.642	0.504
	Ectomorph	0.161	**0,008***	**0,019***	0.785	0.242	0.974

*P<0.05, by the T test goalkeepers

In relation to the somatotype, both endomorph components (relative adiposity) and mesomorph (relative muscularity) did not show any significant differences among the groups studied, though it is important to mention that the highest average of relative muscularity was observed in the attackers, while the lowest was found in the goalkeepers. The only somatotype component with significant differences as to the game positions evaluated, was ectomorphism (relative linearity), the highest in goalkeepers (3.2).

Tables 3 and 4 show p<0.05, according to a T test between goalkeepers and defenders, goalkeepers and wingers, goalkeepers and attackers, defenders and wingers, defenders/attackers, and wingers and attackers, including all the anthropometric measurements (25 measurements), body composition, body indexes, and somatotype.

The goalkeeper/defender comparison showed a significant difference as to height (0.008*), triceps fold (0.035*), and mid-thigh (0.039*), cormic index (0.037*), and skeletal index (0.008*). In concrete, the goalkeepers were taller than the defenders, the differences observed in the skinfolds were irrelevant, as all the groups evaluated had an acceptable adipose mass. Although there were significant differences between goalkeepers and defenders, both showed a mid-trunk and short lower limbs (Canda, 2012). The other variables showed no significant differences.

Likewise, when comparing the goalkeepers/wingers, a significant difference was observed in height (0.002*), seated height (0.035*), biacromial (0.015*), humeral (0.045*), adipose mass (kg) (0.03*), specific fat (kg) (0.049*), bone mass (kg) (0.03*), cormic index (0.008*), and skeletal index (0.002*), and somatotype as an ectomorphic component (0.008*). The goalkeepers were taller than the wingers, obviously, this feature is required for this position, whereas a winger does not need to be so tall. Being taller, goalkeepers have greater bone mass, and they receive a work load with the ball on a daily basis, which tackles the upper body; perhaps the reason why the diameters, especially the humeral, showed significant differences in the wingers.

Although there were differences as to the adipose mass, it was not significant, since the two were within the normal range. Concerning the ectomorphic component of the somatotype, goalkeepers taller than the wingers evidenced higher relative linearity. Therefore, they differed significantly. On the contrary, the wingers showed greater relative muscle mass (mesomorphism). The other variables showed no significant differences.

A comparison between goalkeepers and attackers produced significant differences in height (0.047*), calf perimeter (0.049*), triceps skinfold (0.045*), muscle mass (0.044*), muscle/bone index (0.037*), skeletal index (0.047*), and the ectomorphic component of somatotype (0.019*). Just like the previous comparisons, goalkeepers had a significantly higher size compared to the attackers. The attackers showed greater calf perimeter than the goalkeepers; their significant difference may be associated with the longer runs performed by the former during the game, with greater stimuli of this muscular area. Regardless of the differences between the two positions compared to the skinfolds (triceps), the values were irrelevant, as all the positions showed normal fat mass.

The muscle mass differed significantly between the two positions, greater in the attackers. Besides, these players also showed a significantly higher muscle/bone index than the goalkeepers. On the contrary, the skeletal index and the endomorphic component of the somatotype of goalkeepers was significantly greater than that of the attackers.

The defender/winger comparison only showed significant differences in the max forearm perimeters (0.022*) and calf (0.01*), and the residual mass (0.04). The most relevant was observed in the calf perimeter, the wingers showed significantly higher values than the defenders.

The defender/attackers pairing only showed a significant difference in the subscapular fold (0.018*). Meanwhile, the winger/attacker comparison showed significant differences in the weight (0.031*), residual mass (0.021*), and skin mass (0.009*). What is more, weight was significantly greater in the attackers than the wingers.

DISCUSSION

Considering that performance in acyclic sports, such as soccer (by position), also depends on the particular anthropometric characteristics of the athletes, there is a need to study the anthropometric characteristics, body composition, and somatotype of professional soccer players by position. Moreover, with all the theory constructed using proper measurement techniques and calibrated equipment, a number of anthropometric references can be created for the professional Ecuadoran soccer player.

The averages and standard deviations of every measurement (anthropometric, body composition, and somatotype) were detailed in the results. Furthermore, the significant differences of all these variables were unveiled upon comparison by game position. Accordingly, this information (the Ecuadoran anthropometric profile) should be matched with similar international studies to verify the similarities or differences observed in the Ecuadoran soccer players compared with the players from other areas (Table 5).

In that sense, the studies conducted by Holway, between 2002 and 2009 will be assessed. It comprised 752 professional soccer players in 20 first-division Argentinian clubs (Holway, 2011), and the study done by Rodriguez et al., which comprised 390 professional soccer players belonging to 15 first-division Chilean clubs (Rodríguez, 2019).

Basic measurements

The first observation in table 5 was that the national players were younger (22.4 ±4.9), less heavy (73.7 ±3.3), and not as tall (175.4 ±6.2) as the international groups, on average; being the goalkeepers the most outstanding in terms of weight and height. Most studies reviewed coincide that goalkeepers were younger, with greater weight and height (Mosqueira *et al.,* 2022), (Table 5).

Table 5. *- Anthropometric profile of Ecuadoran, Chilean, and Argentinian professional soccer players*

	ECUADORAN PLAYER PROFILES									
	GOALKEEPERS (n = 7)		DEFENDERS (n = 25)		WINGERS (n = 29)		ATTACKERS (n = 12)		TOTAL (n= 73)	
	MEAN ± SD		MEAN ± SD		MEAN ± SD		MEAN ± SD		MEAN ± SD	
Age (years)	21.5	±4.4	22.3	±5.1	22.3	±4.4	23.1	±6.4	22.4	±4.9
Weight	76.3	±8.8	72.5	±7	69.7	±6.36	76.4	±4.3	73.7	±3.3
Height (cm)	183.9	±3.4	175.3	±6.6	173.1	±5.2	176.2	±4.8	175.4	±6.2

Seated height (cm)	95	±3	91.5	±4.5	91.2	±3.6	92.7	±3.3	91.9	±3.9
Fat mass (kg)	16.7	±1.8	16.1	±3.4	15	±3	16.8	±3.3	15.8	±3.1
Muscle mass (kg)	37.4	±6.3	35.9	±4.5	34.1	±4.1	38.8	±3.8	35.8	±4.7
Residual mass (kg)	8.8	±1.7	7.8	±1.4	8	±1.3	8	±0.9	8	±1.3
Bone mass (kg)	9.3	±0.9	8.8	±0.9	8.8	±0.8	8.7	±0.9	8.8	±0.9
Skin mass (kg)	4.1	±0.4	3.9	±0.3	3.8	±0.3	4.1	±0.2	3.9	±0.3
∑ 6 skinfolds (mm)	47.2	±9.6	53.9	±19.9	48.5	±18.3	55	±18.5	51.3	±18.2
M/B index	4	±0.5	4.1	±0.6	3.9	±0.7	4.5	±0.7	4.1	±0.7
Endomorph	2.1	±0.4	2.5	±1	2.4	±1.1	2.5	±1	2.4	±1
Mesophorm	4.6	±1.1	5.2	±0.9	5	±1	5.5	±1.1	5.1	±1
Ectomorph	3.2	±0.8	2.3	±0.8	2.3	±0.9	1.9	±0.7	2.3	±0.9
CHILEAN SOCCER PLAYER PROFILE										
	GOALKEEPERS (n = 48)		**DEFENDERS (n = 124)**		**WINGERS (n = 124)**		**ATTACKERS (n = 93)**		**TOTAL (n= 406)**	
Age (years)	25.1	±5.5	25.3	±4.8	25.2	±4.7	23.5	±4.1	24.8	±4.8
Weight	81.4	±5.9	77.1	±6.2	71.7	±6	75.2	±7.2	76.4	±6.3
Height (cm)	181.2	±3.8	178.1	±5.5	172.9	±5.6	176.6	±6.1	177.2	±5.3
Seated height (cm)	93.1	±3.2	92.8	±3.8	90.1	±3.1	91.8	±4	92.0	±3.5
Fat mass (kg)	18	±2.1	16.2	±2.6	15	±2	15.5	±2.4	16.2	±2.3
Muscle mass (kg)	40.7	±4.1	38.9	±3.6	35.8	±3.6	37.8	±5.1	38.3	±4.1
Residual mass (kg)	9.4	±1.1	9.2	±1.1	8.9	±1.5	9.1	±1.1	9.2	±1.2
Bone mass (kg)	9.2	±0.9	8.9	±0.9	8.4	±0.9	8.7	±0.9	8.8	±0.9
Skin mass (kg)	4.1	±0.2	4	±0.2	3.8	±0.2	3.9	±0.3	4.0	±0.2
∑ 6 skinfolds (mm)	58.9	±12	51.4	±13.7	50.6	±11.6	48.8	±11.5	52.4	±12.2
M/B index	4.44	±0.53	4.4	±0.51	4.27	±0.42	4.37	±0.58	4.4	±0.5
Endomorph	2.5	±0.5	2.3	±0.7	2.3	±0.6	2.1	±0.6	2.3	±0.6
Mesophorm	5.5	±0.9	5.4	±0.9	5.5	±1	5.3	±1.1	5.4	±1.0
Ectomorph	2.1	±0.7	2.1	±0.7	1.9	±0.8	2.1	±0.7	2.1	±0.7
ARGENTINIAN SOCCER PLAYER PROFILE										
	GOALKEEPERS (n = 81)		**DEFENDERS (n = 237)**		**WINGERS (n = 283)**		**ATTACKERS (n = 151)**		**TOTAL (n= 752)**	
Age (years)	25.3	±5.0	23.9	±4.2	23.8	±3.8	23.8	±5	23.8	±4.3
Weight	83.7	±5.9	77.15	±5.4	73.9	±6.2	78.4	±7.2	76.5	±6.3
Height (cm)	185.4	±4.4	179.1	±4.6	175.8	±5.9	178.7	±6	177.9	±5.5
Seated height (cm)	96.5	±2.5	94.25	±2.85	92.9	±3.2	93.9	±3.5	93.7	±3.2
Fat mass (kg)	18.9	±2.8	16.2	±2.45	15.3	±2.4	16.5	±3.2	16.0	±2.7
Muscle mass (kg)	41.5	±3.6	39	±3.25	37.1	±3.5	39.5	±3.5	38.5	±3.4

Residual mass (kg)	9.7	±1.0	9.25	±0.9	8.9	±0.9	9.4	±0.9	9.2	±0.9
Bone mass (kg)	9.5	±0.9	8.95	±0.8	8.7	±0.8	9.1	±0.9	8.9	±0.8
Skin mass (kg)	4.2	±0.2	4	±0.2	3.9	±0.2	4	±0.2	4.0	±0.2
∑ 6 skinfolds (mm)	58.5	±14.7	49.75	±13.4	48.7	±12.0	52.2	±16.7	50.2	±14.0
M/B index	4.40	±0.44	4.37	±0.395	4.3	±0.4	4.37	±0.36	4.3	±0.4
Endomorph	2.6	±0.7	2.25	±0.65	2.2	±0.6	2.3	±0.8	2.2	±0.7
Mesophorm	5.2	±0.8	5.35	±0.75	5.4	±0.9	5.5	±0.8	5.4	±0.8
Ectomorph	2.5	±0.6	2.25	±0.6	2.1	±0.7	2	±0.7	2.1	±0.7

Body composition

According to graphic 1 The adipose mass and skin mass of the national soccer player have a minimum average difference compared with the groups of international soccer players. Equally, the greatest muscle mass was observed in the Argentinian players (38.5 ±3.4), while the lowest was found in the Ecuadoran players (35.8 ±4.7). In the sample of Ecuadoran soccer players, the attackers showed the greatest muscle mass (38.8 ± 3.8), compared with the Chilean and Argentinian players. Both were observed to have the goalkeepers with the most voluminous musculature (40.7 ± 4.1 and 41.5 ± 3.6) (Figure 1).

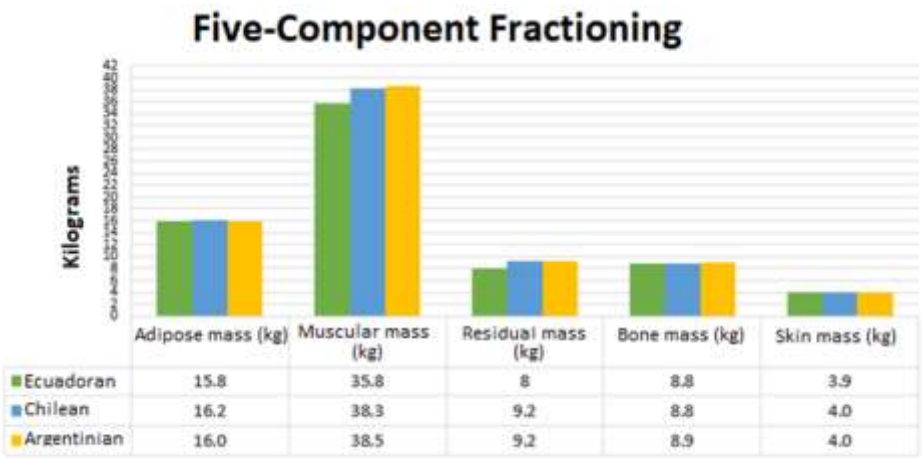

Fig. 1. *- Fractioning of Ecuadoran, Chilean, and Argentinian soccer players into five groups*

The analysis of the body structure of the players is today considered one of the most suitable methods to estimate different areas of athletes (Hernández, 2016), as well as follow-up in pre-competitive and competitive stages (López *et al.,* 2017). For instance, McEwan *et al.* (2020) detailed the "changes in the body composition markers of professional soccer players during the season" (p.3). The players evidenced significant losses of fat mass in all the areas of the body (upper and lower limbs, and the trunk), with no changes in the total mass, and the fat-free mass.

Another study conducted by Trexler *et al.* (2017).

> Revealed "favorable changes in the body composition of university soccer players for a whole year. Despite no significant weight variations were found, the fat percentage was largely reduced, with a concomitant increase of meager mass" (p.6).

To demonstrate the effectiveness of training planning and the nutritional interventions, soccer players are commonly assessed several times during the same season. Besides, the changes in body composition, particularly if it represents an increase of fat mass, may have a negative impact on performance, increase injuries, cause greater energy consumption, carry extra useless load, produce a drop in power and acceleration, bring about a fall in the aerobic capacity, and lead to an altered power/weight ratio (Suarez *et al*. 2018).

Lozada *et al.* (2022) demonstrated in their study that "there is an inversely proportional relation between the thigh and the speed of the ball" (p.5). In other words, the accumulation of fat in the thigh is thought to occur inversely proportional to the necessary work, the explosive action of shooting.

As to the sum of 6 skinfold thickness, the Ecuadoran soccer players have a mean of 51.3 ±18.2mm, while the Chileans and Argentinians have 52.4±12.2mm and 50.2±14.0mm, respectively. None differed significantly from the sum of 6 skinfold thickness reference in soccer (50 mm) (Holway, 2010). Likewise, Kasper *et al.* (2021) suggested "references for a sum of 8 skinfold thickness in high-performance players. Low 4 045 mm, mid 4 555mm, high 5 565 mm" (p.13). Although it is true that the skinfold sum is not a quantifier of fat kg, it is a very useful indirect indicator to determine if the fat levels are high, when compared with the same references, depending on the different sports disciplines.

Indexes

The muscle-bone index permits observing how much muscle mass in kg can be carried by every bone kg (López and Lara, 2021). The ratio is 5:1, 5 kg of muscle mass per every bone kg. The Ecuadoran soccer players showed a lower muscle-bone index average (4.1 ±0.7) than the Chilean players (4.4 ±0.5), and the Argentinian players (4.3±0.4). According to ARGOREF references, in physically active people, the muscle-bone average was 4.3, max. and 5.2-min.3.2 in males. The samples compared did not differ significantly from the reference.

Somatotype

It is favorable in disciplines where the body configuration might influence the outcome of performance (Gutnik *et al.,* 2015). Therefore, the four positions were evaluated in the Ecuadoran case, all coinciding with a predominant mesomorphic component: the attackers evidenced the greatest relative muscularity, having a somatotype of 2.5-5.5-1.9 (Figure 2).

The Ecuadoran player's average somatotype is 2.4-5.1-2.3, and did not differ from the international groups, with a balanced mesomorphism (Carter and Heath, 1990) (Figure 3).

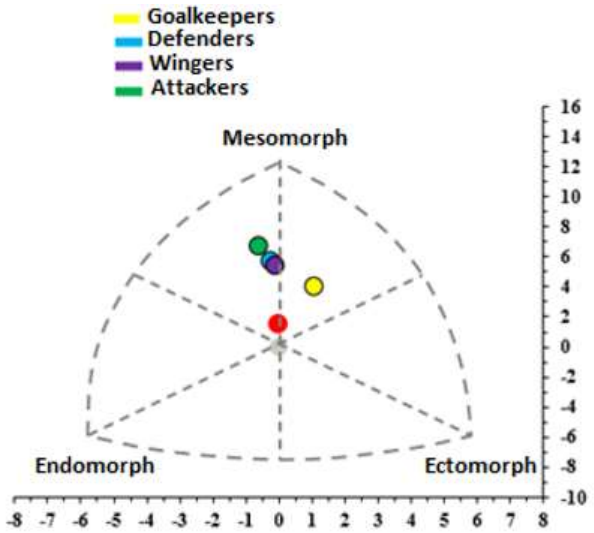

Fig. 2. *- Somatotype of professional Ecuadoran soccer players by position*

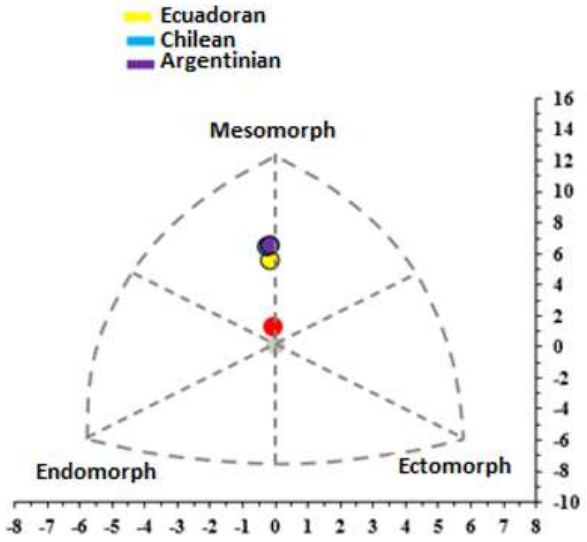

Fig. 3. *-Somatotype of Ecuadoran, Chilean, and Argentinian soccer players*

The somatotype of professional players varied in comparison with the American football players, according to a study done by Carrasco *et al.* (2021). The study "evidenced an average somatotype of 4.2-6.4-0.97 in 90 professional American football players from Mexico, with a meso-endomorphic somatotype" (p.10).

CONCLUSIONS

The anthropometric characteristics, body composition, and somatotype of professional Ecuadoran soccer players by position and overall average were determined. The data showed the existence of significant differences among the variables studied by game position. Besides, when matching the anthropometric profile of Ecuadoran players with international players, the former evidenced different basic measurements, with lower muscle mass. However, the fat mass, sum of 6 skinfold thickness, muscle-bone index, and somatotype were remarkably similar.

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Conflict of interest statement
The authors declare no conflicts of interests.

Author contribution statement
The authors have taken part in the redaction of the manuscript and analysis of the documents.