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Review

Differences in Body Composition between Playing Positions in Men's Professional Soccer: A Systematic Review with Meta-Analysis

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Featured Application: This research shows the results of the body composition of male professional soccer players differentiated by playing positions, which until now had not been analyzed. These results could be a guide for the medical and technical staff when focusing on and individualizing training objectives to achieve maximum performance.

Abstract: The performance of male soccer players (MSPs) depends on multiple factors, such as body composition. It is understandable to think that, due to the physical demands and specific functions during play, body composition may vary depending on the playing position. The aim of this systematic review and meta-analysis was to describe the anthropometric, BC, and somatotype characteristics of professional MSPs and to compare the reported values according to playing position. We systematically searched Embase, PubMed, SPORTDiscus, and Web of Science following the PRISMA statement. Random-effects meta-analysis, a pooled summary of means, and 95% CI (method or equation) were calculated. Random models were used with the Restricted Maximum Likelihood (REML) method. Twenty-six articles were included in the systematic review and the meta-analysis. After comparing the groups according to the playing position (goalkeeper, defender, midfielder, and forward), significant differences were found in age, height, weight, the sum of skinfolds, kilograms of muscle mass, and kilograms of fat-free mass (p = 0.001; p < 0.0001). No significant differences were observed in fat mass, percentage of fat-free mass, percentage of muscle mass, bone mass, and somatotype. Despite the limitations, this study provides useful information to help medical–technical staff to properly assess the BC of professional MSPs, providing reference values for the different positions.

Keywords: soccer; body composition; anthropometry; bioimpedance; DXA

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1. Introduction

In soccer, athletes cover an average total distance during a full match (90 min plus added injury time) of around 8–14 km and are characterized by a highly variable pattern of actions such as walking, jogging, running at high and low speeds, sprinting, moving backward, kicking, jumping, or tackling [1–8]. However, the distances covered depend mainly on (i) the time played (linked to substitutions during the match), (ii) the team's style of play, (iii) the number of matches in the same week, or (iv) the different playing positions [8].

Barros et al. [2] observed a greater distance covered by lateral defenders, midfielders, and wingers compared to forwards and central defenders. These results are similar to another study [3], where midfielders and wingers covered greater distances than lateral defenders, forwards, and central defenders after analyzing 20 Spanish league matches and 10 Champions League matches. In addition, goalkeepers during training and matches tend to cover a total distance of around 50% less than other positions [9,10]. It is, therefore, plausible that, due to the physical demands and specific roles during play, body composition may vary according to playing position.

Kineanthropometry is the area of science responsible for measuring the composition of the human body. Changes in nutrition, lifestyle, physical activity, and ethnic composition of populations are some of the factors that can modify body dimensions [11]. In sports (including soccer), the main assessment methods used are anthropometry, bioelectrical impedance analysis (BIA), and dual X-ray densitometry (DXA) [12,13]. The somatotype is another relevant tool in the study of body composition, defined as the quantification of the shape and composition of the human body through the numerical qualification of three components using different anthropometric formulas and measurements [14]. Derived from the somatotype, the somatocarta is a graphic representation expressed in endomorphy, mesomorphy, and ectomorphy (three components). It is useful in the field of sports to be able to situate the somatotype of the athlete being evaluated against the reference somatotype of the sport he/she practices based on a wide collection of data [15]. In soccer, body composition is decisive for reaching an optimal physical level, which can translate into a good level of play, as performance in this sport depends on multiple technical, biomechanical, tactical, mental, and physiological factors [16]. Recently, our research group studied, through a systematic review and meta-analysis, the existing differences in the analysis of body composition in male professional soccer players between different measurement methods (anthropometry, BIA, and DXA) [17]. However, due to the limitations of the study, it was not possible to specify these values between the different playing positions.

The aim of the present systematic review with meta-analysis was to describe anthropometric characteristics, body composition, and somatotypes in male professional soccer players and to compare the reported values according to playing position. Accordingly, it was initially hypothesized that:

Hypothesis (H1). *There will be significant differences between the different playing positions, especially in height, weight, skinfold sum, and muscle mass (MM).*

Hypothesis (H2). *Goalkeepers have the most different body composition values compared to the rest of the playing positions, with a higher weight, height, skinfold sum, and MM due to their sporting role.*

2. Materials and Methods

2.1. Type of Study

A systematic review and meta-analysis were conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) about the evidence on anthropometric characteristics, body composition, and somatotype of professional male soccer players by playing position [18].

2.2. Information Sources and Search Strategy

The databases searched were PubMed-MEDLINE, Embase, SPORTDiscus, and Web of Science. To find the largest number of available articles related to the research aim, the words used in the search strategy were defined considering: (1) soccer (football); (2) anthropometry, body composition, and somatotype; (3) athlete (professional or elite);

(4) the descriptors of the Medical Subjects Headings (MeSH); (5) other terms described in MeSH as "entry terms", which include the terminology prior to the setting-up of the MeSH register; and (6) the terms [tiab] or [Title/Abstract] attached to the "entry terms" or MeSH, which allow the localization of these terms in the title and abstract of the articles.

The words and the search strategy are in Appendix A. The search strategy was adapted for each of the databases through the Polyglot Search of the Systematic Review Accelerator tool (https://sr-accelerator.com/#/polyglot, accessed on 1 February 2023).

The timeframe for the search included studies from the year 2000 until January 2023. Due to the fact that the physical demands of soccer players have evolved over the decades, they are currently more demanding and require different body composition characteristics [19].

2.3. Eligibility Criteria

The Participants, Intervention, Comparison, and Outcomes (PICO) criteria for the inclusion and exclusion criteria are shown in Table 1. No limits were placed in relation to the publication status of the study (pre-print, post-print, first online, or final).

Table 1. The inclusion criteria applied in the study followed the Population, Intervention, Comparison, and Outcomes (PICO) strategy.

Population	Intervention	Comparison	Outcomes
Male soccer players who train with the aim of competing or improving their physical performance (excludes physical activity for health or aesthetics). Professional category. Absence of pathologies (healthy subjects).	Anthropometry. Bioimpedance (BIA). Dual X-ray Absorptiometry (DXA).	Playing position.	Anthropometric characteristics: skinfolds, girth, breadth, heights, lengths, body composition, and somatotype. Percentages and values of fat mass, muscle mass, and bone mass.

The exclusion criteria included: (a) studies published in a language other than Spanish and/or English and (b) narrative, systematic reviews, and/or meta-analyses.

2.4. Article Management Process

All the documents found were incorporated into the Zotero citation manager in a separate folder by the database in which they were found. A common folder was created to detect and delete duplicated articles using the software's degree of data overlap. The final database was exported in RIS format to be imported into the article screening system for further processing by the researchers.

2.5. Study Selection

All retrieved articles were screened in duplicate. The first screening, based on the title and abstract, was independently conducted in all the studies by two authors (JS-R and JMM-S). During the processes of identifying and screening, a third researcher was consulted (JMS) to determine if the documents that led to discrepancies between authors had to be included or excluded. The articles eligible for a full-text review were then screened by the same authors (JS-R and JMM-S), independently and in duplicate. The rejected articles were then duly identified using the eligibility criterion previously established. Additional reviewers (JMS, NG-G) provided advice when feedback about doubtful documents was required.

2.6. Data Extraction

The studies' information was extracted following a blinded and duplicated protocol by two authors (JS-R and JMM-S) using a previously piloted data extraction survey created for this review. The data extraction protocol for this study consisted of the following variables:

- Study: Authors and year of publication.
- Sample size: Number of subjects and playing position.

- Country and competition category: Geographical area and competitive category from which the data comes. The latter was included to differentiate between professional league categories within the same country.
- Time of Season: Included to differentiate values collected between different cycles of a natural season (if specified).
- Measuring instruments: Description of the material used in the evaluation.
- Evaluation method: It was included to differentiate the values collected between the three methods of evaluation of body composition (anthropometry with the protocol used, BIA, and DXA).
- Main results: Kinanthropometric characteristics and values of FM, MM, bone mass (BM), and body water (Supplementary Tables S1–S3).

2.7. Study Quality and Data Collection

Two researchers (JS-R and JMM-S) examined the quality of the studies using the Agency for Health Research and Quality (AHRQ) Methodology Checklist [20]. A third reviewer (JMS) was consulted to resolve discrepancies. A score above 8 was considered a high-quality study. The bias statistic of Egger's [21] was used to assess the risk of bias, and funnel plots were created. When a meta-analysis was based on a small number of studies, the ability of Egger's test to detect bias is limited [22]. Therefore, this test should be performed when there are at least 10 studies included in the meta-analysis [21].

2.8. Statistical Analysis

The meta-analysis was performed with the R software version 3.6.0. Copyright (C) 2019 (R Foundation for Statistical Computing). The meta-analysis was performed for continuous data using sample (n), mean (M), and standard deviation (SD) of each output from each study. Some studies had more than one group and were treated as other subgroups in the analysis. In the random-effects meta-analysis, a pooled summary mean, and 95%CI were calculated. Studies were weighted according to the samples within and between studies. A pooled summary mean and 95% CI were calculated for subgroups (method or equation) in order to compare the differences between groups. Random models using the Restricted Maximum Likelihood Method (REML) were utilized. The heterogeneity was measured using the I^2 statistic, considering a high heterogeneity if $I^2 \geq 75\%$. The level of significance adopted was 5% ($p < 0.05$).

3. Results

A total of 26 studies were included in this study (Figure 1). The sample comprising the different papers included in the review amounted to a total of 3117 soccer players, being 1025 defenders (combining central defenders and lateral defenders), 1093 midfielders (combining defensive midfielders, central defenders, offensive midfielders, and wingers), 691 forwards, and 308 goalkeepers.

Table 2 shows the qualitative characteristics of the included articles. Figure 2 shows the risk of bias summary: authors' judgments broken down for each risk of bias criterion across all included studies.

In relation to the method of measurement, on 12 occasions, they were based on the use of anthropometry [23–34], six in BIA [35–40], seven in DXA [41–47], and one combined anthropometry and BIA [48].

In relation to the anthropometric measuring instrument, the main one used was the Harpenden picometer (n = 7) [23,24,26,27,31,32,48]. For BIA, the most commonly used model was the Tanita BC 418 MA (n = 3) [37,38,48]. Lastly, the most common DXA machine model was Hologic QDR Series Discovery A (n = 2) [43,44].

Of the 13 articles included where anthropometry was used as a method of evaluation, seven used the International Society for the Advancement of Kinanthropometry protocol (ISAK) [24,25,29,30,32,33,48], one utilized the Anthropometric Standardization Reference Manual (ASRM) protocol [28], one used the International Biological Program

(IBP) protocol [26], one used Sistema de Acreditación en Técnicas Antropométricas (SATA) protocol [34], and the remaining three articles did not specify the protocol applied [23,27,31].

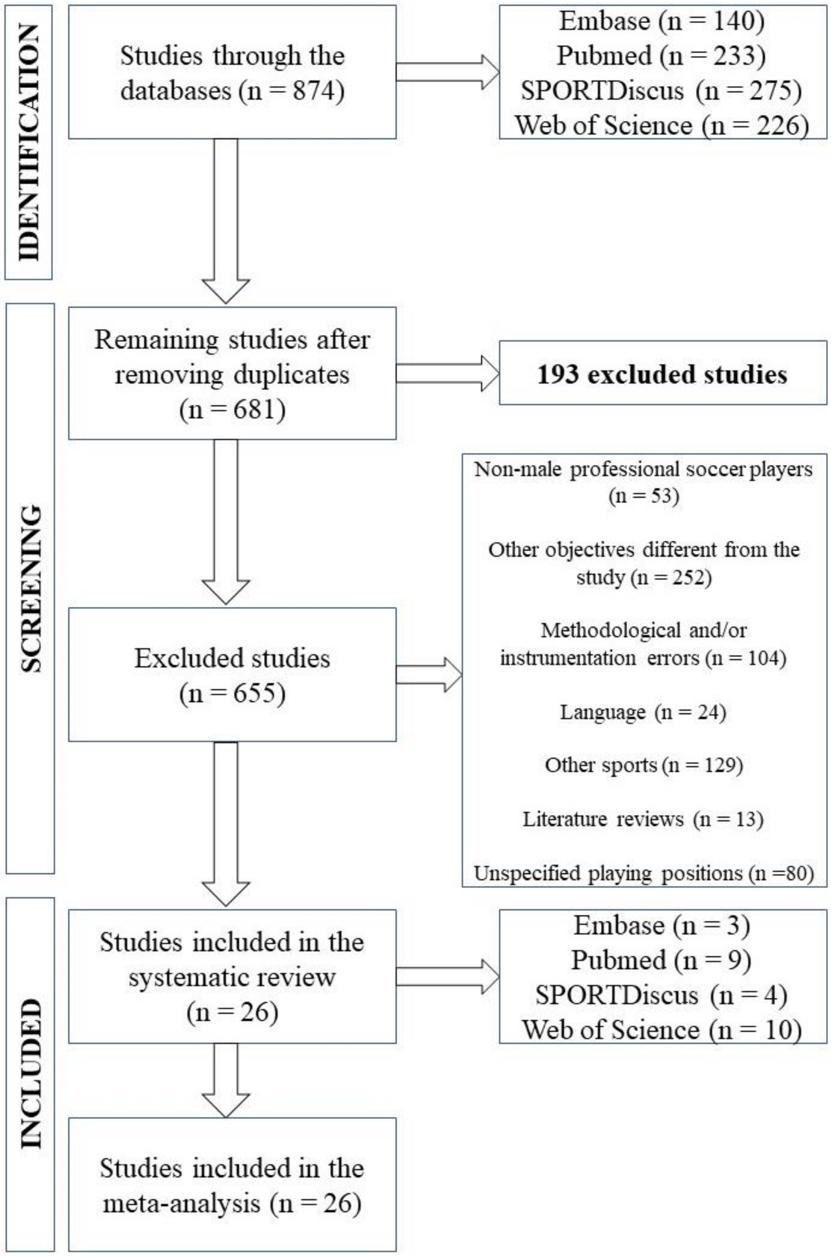

Figure 1. Flow diagram showing the process used to select the studies.

As for the sum of skinfolds, the most commonly used formulas were the sum of six skinfolds (triceps, subscapular, supraspinal, abdominal, mid-thigh, and calf) (n = 3) [25,30,33]. Regarding the percentage of FM, none of the seven equations predominated, being present in only one article each. Information on the anthropometric FM equations used in each of the studies is available in the Supplementary Tables S1–S3.

Meta-analysis grouped according to the playing position (1 = goalkeeper; 2 = defender, 3 = midfielder; 4 = forward) is shown in Table 3 and Supplementary Figures S1–S14. The sample had a mean age of 24.4 years old, 180 cm in height, 76.8 kg in weight, 54.56 of the sum of skinfolds, 11.89% of FM, 11.14 kg of FM, 47.01% of MM, 38.59 kg of MM, 64.7 kg of FFM, 2.31 of endomorphy, 2.30 of ectomorphy, 5.06 of mesomorphy, 1.35 for bone mineral density (BMD), and 3.33 for bone mineral content (BMC).

Table 2. Descriptive characteristics of the included studies.

Authors and Year	Sample Size (n)	Age (Years)	Country. Competition Category	Time of the SEA	Measuring Instruments	Evaluation Method
Wittich et al. [45]	T = 42; DEF = 14; CEN = 14; DEL = 14; POR = 4	23.2 ± 3.50; 22.0 ± 2.90; 24.0 ± 3.60; 22.0 ± 1.70; -	AR. 1st División	3 pre-SEAs	GE Lunar DPX-L software 1.33	DXA
Sporis et al. [26]	T = 270; DEF = 80; CEN = 80; DEL = 80; POR = 30	28.3 ± 5.90; 27.3 ± 2.30; 25.1 ± 3.10; 24.2 ± 3.20; 31.5 ± 2.30	HR. Prva HNL	2 consecutive pre-SEAs	BAS Seca, PLI John Bull Caliper	A-IBP
Sutton et al. [44]	T = 64; DEF = 20; CEN = 22; DEL = 14; POR = 8	26.2 ± 4.00; 26.7 ± 4.40; 26.5 ± 3.90; 25.6 ± 4.30; 25.0 ± 3.30	EN. Premier League	-	BAS y EST Seca 702, Hologic QDR Series Discovery A software 12:4:3	DXA
Dey et al. [27]	T = 150; DEF = 44; CEN = 48; DEL = 35; POR = 23	23.3 ± 3.50; 23.1 ± 3.20; 23.3 ± 3.60; 23.2 ± 3.40; 23.3 ± 3.9	IN. Super League	-	PLI Harpenden	A-n.s.
Hazir [28]	T = 305; DEF = 90; CEN = 120; DEL = 56; POR = 39	SL = 25.7 ± 3.70 FL = 24.1 ± 4.20	TR. Süper Lig (161) y TFF 1. Lig (144)	5 beginnings of the transition period for the SEA half	BAS Tanita TBF 401A, EST Holtain, Bicondylar caliper Holtain, PLI Holtain	A-ASRM
Boone et al. [23]	T = 289; central DEF = 60; lateral DEF = 82; CEN = 62; DEL = 62; POR = 17	25.4 ± 4.90; -; -; -; -	BE. Jupiler Pro League	2–4 weeks prior to start of SEA	BAS Seca, PLI Harpenden	A-n.s.
Henríquez-Olguín et al. [29]	T = 100; central DEF = 17; lateral DEF = 14; deffensive CEN = 18; offensive CEN = 17 DEL = 23; POR = 11	23.0 ± 4.40; 24.8 ± 4.00; 23.2 ± 2.60; 23.8 ± 4.90; 23.3 ± 3.8; 23.2 ± 4.5; 23.0 ± 4.4	CL. Not specified	2 SEA starts	BAS Tanita TBF 401A, Kit Health & Performance®	A-ISAK
Jorquera et al. [30]	T = 406; DEF = 124; CEN = 134; DEL = 93; POR = 48	-; 25.3 ± 4.80; 25.2 ± 4.70; 23.5 ± 4.10; 25.1 ± 5.50	CL. 1st División (326) y 1st B (80)	-	BAS Tanita, Kit Gaucho Pro "Mercosur"	A-ISAK
Gerosa-Neto et al. [46]	T = 82; DEF = 10; central CEN = 25; lateral CEN = 15; DEL = 22; POR = 10	23.6 ± 4.20; 24.8 ± 4.70; 22.7 ± 6.50; 24.0 ± 8.60; 23.6 ± 8.20; 23.5 ± 9.60	BR. BReirão Serie A	Pre-SEA	BAS Filizola, EST Sanny, GE Lunar DPX-MD software 4.7	DXA
Milanese et al. [42]	T = 29; DEF = 13; CEN = 7; DEL = 5; POR = 4	27.5 ± 4.38; -; -; -; -	IT. Serie A	3 full SEAs	BAS Tanita BWB-800MA, EST Harpenden, QDR Explorer W software 12.6.1	DXA
Milsom et al. [43]	T = 27; DEF = 10; CEN = 9; DEL = 4; POR = 4	24.1 ± 3.90; -; -; -; -	EN. Premier League	3 full SEAs (different periods)	BAS Seca, Hologic QDR Series Discovery A	DXA

Table 2. *Cont.*

Authors and Year	Sample Size (n)	Age (Years)	Country. Competition Category	Time of the SEA	Measuring Instruments	Evaluation Method
Najafi et al. [31]	T = 60; DEF = 18; CEN = 20; DEL = 14; POR = 8	24.3 ± 4.20; -; -; -; -	IR. Iran Pro League y Azadegan League	-	BAS Seca, PLI Harpenden	A-n.s.
Sánchez-Ureña et al. [47]	T = 106; central DEF = 21; lateral DEF = 14; CEN = 34; DEL = 22; POR = 15	24.5 ± 4.77; 25.0 ± 5.00; 24.9 ± 4.40; 22.5 ± 3.40; 23.4 ± 4.60; 26.4 ± 6.00	CR. 1st División	-	BAS Tanita HD-313, EST Tanita, GE enCORE 2011 software 13.6	DXA
Semjon et al. [37]	T = 120; central DEF = 18; lateral DEF = 15; central CEN = 24; W = 18; DEL = 34; POR = 11	-; 27.3 ± 6.20; 26.7 ± 4.80; 25.8 ± 5.30; 25.3 ± 4.20; 24.0 ± 3.06; 26.6 ± 6.50	RC. Českou fotbalova liga	6 consecutive pre-SEAs	BAS Leifheit Soehnle 7307, Tanita BC 418 MA	BIA
Kafedžić et al. [36]	T = 39; central DEF = 4; lateral DEF = 8; CEN = 14; W = 5; DEL = 8	23.5 ± 4.60; 22.3 ± 3.40; 24.9 ± 4.40; 22.1 ± 5.00; 24.4 ± 3.00; 24.6 ± 5.80	BA. Premier League	2 pre-SEA starts	Holton Anthropometer, Tanita BC 420SMA	BIA
Owen et al. [24]	T = 22; DEF = 8; CEN = 8; DEL = 6	24.0 ± 3.70; -; -; -	EU	Start and end pre-SEA, mid-SEA, end mid-SEA transition period, and end SEA	BAS CIRCA, EST CIRCA, Bicondylar caliper Gulick, PLI Harpenden	A-ISAK
Rodríguez-Rodríguez et al. [25]	T = 339; DEF = 119; CEN = 133; DEL = 94; POR = 44	-; 25.3 ± 4.80; 25.2 ± 4.80; 23.5 ± 4.10; 25.1 ± 5.50	CL. 1st División	-	Kit Gaucho Pro “Mercosur”	A-ISAK
Granero-Gil et al. [35]	T = 30; central DEF = 4; lateral DEF = 5; central CEN = 8; lateral CEN = 5; DEL = 8	26.5 ± 5.56; 33.7 ± 5.59; 28.3 ± 3.55; 24.2 ± 4.51; 25.0 ± 4.27; 23.7 ± 2.93	RU. Russian Premier League	During competitive SEA	EST Seca, Tanita SC-240	BIA
McEwan et al. [41]	T = 20; DEF = 7; CEN = 7; DEL = 6	25.1 ± 4.10; -; -; -	ES. 1st División	Start and end of two pre-SEAs	GE Lunar	DXA
Vega et al. [32]	T = 41; central DEF = 5; lateral DEF = 10; central CEN = 11; lateral CEN = 5; DEL = 7	-	ES. 1st División y 2nd División	10 full SEAs	BAS Seca 719, EST Seca 213, PLI Harpenden	A-ISAK
Castro Jiménez et al. [48]	T = 24; DEF = 5; CEN = 13; DEL = 4; POR = 2	21.0 ± 1.90; -; -; -; -	CO. 1st B	-	BIOInBody 770, EST Seca, Bicondylar caliper Holtain, PLI Harpenden HSK-BI	A & BIA -ISAK

Table 2. *Cont.*

Authors and Year	Sample Size (n)	Age (Years)	Country. Competition Category	Time of the SEA	Measuring Instruments	Evaluation Method
Hernández-Mosqueira et al. [33]	T = 158; DEF = 46; CEN = 58; DEL = 34; POR = 20	24.1 ± 4.70; 25.3 ± 5.20; 24.5 ± 4.90; 23.9 ± 3.90; 22.8 ± 4.80	CL. 1st División	5 consecutive pre-SEAs	EST Seca 700, Kit Gaucho Pro “Mercosur”	A-ISAK
Moya-Amaya et al. [34]	T = 23; DEF = 6; CEN = 10; DEL = 5; POR = 2	24.0 ± 3.25; 23.8 ± 3.25; 23.9 ± 4.23; 25.0 ± 1.58; 23.0 ± 1.41	IT. Serie A	Half SEA	EST Seca 264, Measuring tape SATA, PLI Slimguide	A-SATA
Parpa & Michaelides [38]	T = 308; central DEF = 69; lateral DEF = 53; CEN = 87; W = 41; DEL = 40	25.4 ± 4.66; -; -; -; -; -	EM. 1st División	2 consecutive pre-SEAs	EST Tanita, Tanita BC418 MA	BIA
Staśkiewicz et al. [40]	T = 38; DEF = 12; CEN = 15; DEL = 6; POR = 5	25.9 ± 5.22; 27.5 ± 4.50; 24.1 ± 4.69; 25.5 ± 5.89; 27.8 ± 7.19	PL. Ekstraklasa	Full SEA	InBody 770	BIA
Staśkiewicz et al. [39]	T = 38; DEF = 12; CEN = 15; DEL = 6; POR = 5	25.89 ± 5.22; 27.5 ± 4.5; 24.13 ± 4.69; 25.5 ± 5.89; 27.8 ± 7.19	PL. Ekstraklasa	Full SEA	InBody 770	BIA

A = Anthropometry; AR = Argentina; ASRM = Anthropometric Standardization Reference Manual; BA = Bosnia and Herzegovina; BAS = Scale; BE = Belgium; BIA: bioimpedance; BR = Brazil; CEN = Midfielders; CL = Chile; CO = Colombia; CR = Costa Rica; DEF = Defenders; DEL = Forwards; DXA: Dual X-ray densitometry; EM = Eastern Mediterranean players; EN = England; ES = Spain; EST = Stadiometer; EU = European players; FL = Turkish 1 Lig; HR = Croatia; IBP = International Biological Program; IR = Iran; IT = Italy; ISAK = International Society for the Advancement of Kinanthropometry; PL = Poland; PLI = Plicometer; POR = Goalkeepers; RC = Czech Republic; RU = Russia; SATA = Sistema de Acreditación en Técnicas Antropométricas; SL = Turkish Süper Lig; T = Total; SEA = Season; TR = Turkey; W = Wingers.

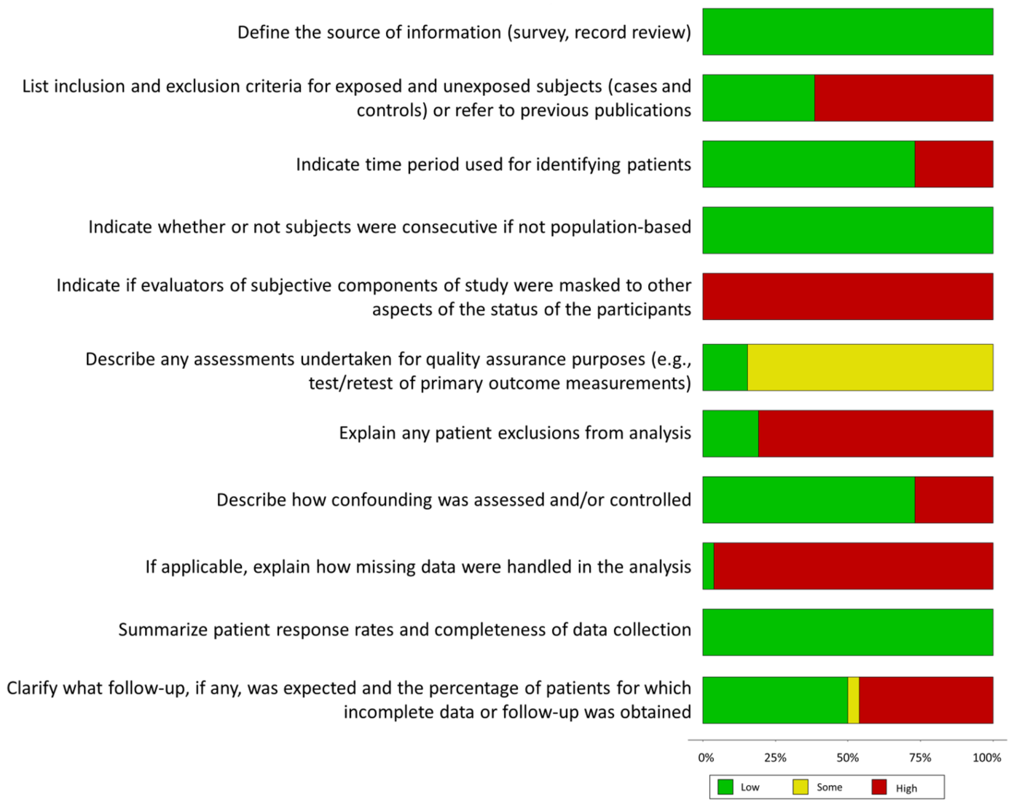

Figure 2. Risk of bias summary: authors´ judgments broken down for each risk of bias criterion across all included studies.

Table 3. Meta-analysis by groups according to the playing position. G = groups; M = mean.

	Authors	G	M	95% CI	Weight (%)	M	95% CI	*p*
			Age					
Goalkeeper	[25–30,33,34,37,39,40,44,46,47]	16	25.7	24.2; 27.3	17.0	24.9	24.4; 25.3	0.002
Defender	[25–30,33–37,39,40,44–47]	24	25.5	24.6; 26.3	29.1			
Midfielder	[25–30,33–37,39,40,44–47]	22	24.4	23.9; 24.9	27.7			
Forward	[25–30,33–37,39,40,44–47]	21	24.0	23.6; 24.4	26.2			
			Height					
Goalkeeper	[23,25–34,37,39,40,43,44,46–48]	22	186	184; 188	19.1	180	179; 181	<0.001
Defender	[23,25–40,43–48]	34	181	179; 182	29.8			
Midfielder	[23,25–40,43–48]	30	176	175; 178	26.4			
Forward	[23,25–40,43–48]	29	179	178; 180	24.7			
			Weight					
Goalkeeper	[23,25–34,37,39,40,43,44,46–48]	22	82.4	80.2; 84.7	18.7	76.9	75.9; 77.9	<0.001
Defender	[23,25–41,43–48]	35	77.4	75.8; 79.0	29.5			
Midfielder	[23,25–41,43–48]	31	72.7	71.3; 74.1	27.4			
Forward	[23,25–41,43–48]	30	76.5	75.1; 77.9	24.4			
			Sum of 6 skinfolds					
Goalkeeper	[25,30,33]	3	58.9	58.3; 59.4	19.4	54.6	54.5; 57.7	0.038
Defender	[24,25,30,33]	4	54.9	43.0; 66.7	27.6			
Midfielder	[24,25,30,33]	4	53.9	46.2; 61.6	27.6			
Forward	[24,25,30,33]	4	52.5	41.0; 64.0	25.5			

Table 3. *Cont.*

	Authors	G	M	95% CI	Weight (%)	M	95% CI	*p*
Fat mass percentage								
Goalkeeper	[23,26,27,31–33,37,39,42–44,46–48]	14	13.6	11.5; 15.7	15.7	11.9	11.2; 12.6	0.285
Defender	[23,26,27,31–33,35–39,41–48]	26	11.6	10.5; 12.6	31.4			
Midfielder	[23,26,27,31–33,35–39,41–48]	22	11.6	10.1; 13.1	26.8			
Forward	[23,26,27,31–33,35–39,41–48]	22	11.6	10.3; 12.8	26.1			
Fat mass kg								
Goalkeeper	[25,33,39,42,43,46]	6	13.2	8.58; 17.8	18.8	11.1	9.77; 15.5	0.539
Defender	[24,25,33,39,41–43,46]	8	11.3	8.12; 14.5	26			
Midfielder	[24,25,33,39,41–43,46]	9	10.1	7.35; 12.9	29.3			
Forward	[24,25,33,39,41–43,46]	8	10.6	7.83; 13.4	25.9			
Muscle mass percentage								
Goalkeeper	[33]	1	49.5	48.1; 50.9	11.5	47.0	45.5; 48.6	0.065
Defender	[33,36]	3	46.5	41.4; 51.7	31.6			
Midfielder	[33,36]	2	47.1	30.0; 64.2	24.1			
Forward	[33,36]	3	46.5	40.1; 52.9	32.8			
Muscle mass kg								
Goalkeeper	[25,33,39,48]	4	40.8	38.4; 43.2	23.5	38.6	37.2; 40.0	0.001
Defender	[25,33,39,48]	4	39.7	36.0; 43.4	25.5			
Midfielder	[25,33,39,48]	4	35.9	32.4; 39.4	26.5			
Forward	[25,33,39,48]	4	37.9	36.2; 39.5	24.5			
Fat-free mass kg								
Goalkeeper	[39,42,43,46,47]	5	69.1	64.1; 74.2	17.1	64.7	62.7; 66.6	0.009
Defender	[24,39,41–43,46,47]	8	65.0	59.7; 70.2	29.5			
Midfielder	[24,39,41–43,46,47]	8	61.9	59.3; 64.5	29.7			
Forward	[24,39,41–43,46,47]	7	64.4	60.5; 68.4	23.7			
Endomorphy								
Goalkeeper	[25,28,29,33,34,48]	7	2.41	1.78; 3.04	21.3	2.31	2.13; 2.50	0.890
Defender	[25,28,29,33,34,48]	8	2.27	1.94; 2.60	27.5			
Midfielder	[25,28,29,33,34,48]	8	2.37	2.03; 2.71	28.2			
Forward	[25,28,29,33,34,48]	7	2.22	1.72; 2.72	23.0			
Ectomorphy								
Goalkeeper	[25,28,29,33,34,48]	7	2.50	2.18; 2.81	19.6	2.30	2.18; 2.42	0.425
Defender	[25,28,29,33,34,48]	8	2.29	2.09; 2.49	29.6			
Midfielder	[25,28,29,33,34,48]	8	2.25	1.94; 2.55	29.9			
Forward	[25,28,29,33,34,48]	7	2.23	1.91; 2.55	20.9			
Mesomorphy								
Goalkeeper	[25,28,29,33,34,48]	7	4.53	4.52; 5.43	19.5	5.06	4.88; 5.23	0.963
Defender	[25,28,29,33,34,48]	8	4.77	4.77; 5.37	29.7			
Midfielder	[25,28,29,33,34,48]	8	4.71	4.71; 5.42	28.7			
Forward	[25,28,29,33,34,48]	7	4.46	4.46; 5.83	22.0			
Bone mineral density								
Goalkeeper	[42,44,46,47]	4	1.35	1.21; 1.49	22.1	1.35	1.31; 1.39	0.983
Defender	[42,44,46,47]	5	1.34	1.23; 1.45	28.5			
Midfielder	[42,44,46,47]	5	1.36	1.28; 1.45	27.4			
Forward	[42,44,46,47]	4	1.35	1.22; 1.47	22.0			
Bone mineral content								
Goalkeeper	[42,47]	2	3.47	−1.36; 8.30	22.3	3.33	3.01; 3.64	0.916
Defender	[42,47]	3	3.39	2.07; 4.71	34.2			
Midfielder	[42,47]	2	3.19	−0.94; 7.31	22.1			
Forward	[42,47]	2	3.20	−0.47; 6.88	21.4			

When comparing the results by playing position, a significant difference was found in age (0 = 0.002), with goalkeepers and defenders being older and forwards being younger; height ($p < 0.001$), with midfielders being the shortest in height and goalkeepers the tallest; weight ($p < 0.001$), with goalkeepers being the heaviest and midfielders the lightest; skinfold sum ($p = 0.038$), with the goalkeeper presenting the highest sum, followed by the defenders, midfielders, and forwards; kilograms of MM ($p = 0.001$), with goalkeepers and defenders showing greater MM and midfielders and forwards showing less MM; and kilograms of FFM ($p = 0.009$), with goalkeepers having more kilograms of FFM. No significant differences were found for the other variables.

4. Discussion

This is the first systematic review with meta-analysis that evaluates body composition in male professional soccer players differentiated by playing positions. The main findings of this study were: (1) goalkeeper is the playing position showing the highest height, age, total weight, sum of six skinfolds, and MM; (2) defender is the position showing the highest age and MM (next to goalkeepers); (3) midfielder has been shown to be the playing position with the lowest height, total weight, and MM; (4) forwards appear to be the youngest, with lower skinfold summation and lower MM (next to midfielders); (5) no significant differences were observed in BMC, BMD, somatotype, weight, and percentage of FM.

4.1. Body Composition Values

In soccer, there are different playing positions with their own demands and characteristics [2,3,9,10,49]; several working groups have tested whether or not there are significant differences in body composition [16,44,50]. While most studies apply a horizontal subdivision for playing positions (goalkeeper, defender, midfielder, and forward), it would be advisable to also make a vertical subdivision (central defender, lateral defender, attacking midfielder, central midfielder, defensive midfielder, and winger) to further specify the anthropometric characteristics, activity profiles, and/or physiological demands of each player [49].

Previously some studies investigated the differences in body composition between different playing positions. In a study of 64 professional players from four different English Premier League teams, body composition was analyzed by DXA, dividing the subjects by playing positions (goalkeeper, defender, midfielder, and forward). Goalkeepers differed from the other positions in both anthropometric and body composition variables, being the tallest (1.90 $\pm$ 0.03 m), heaviest (91.2 $\pm$ 4.60 kg), and with the highest percentage of FM (12.9 $\pm$ 2.00%) [44]. Most recently, Cavia et al. also analyzed the differences between the different playing positions (goalkeeper, defense, midfielder, and forward) in 57 soccer players of the same Spanish league club through anthropometry and BIA. The highest fat percentages were obtained in goalkeepers (9.40 $\pm$ 1.40%), followed by defenders (8.00 $\pm$ 1.60%) with respect to the rest of the positions (midfielders 7.40 $\pm$ 1.30% and forwards 7.70 $\pm$ 1.40%) [16]. Ziv & Lidor published a review where they evaluated the physical characteristics and physiological attributes of goalkeepers, highlighting that they are generally taller than 180 cm, with a body weight over 77.0 kg and a percentage of FM around 12.0–14.0% [50]. Lastly, the Union of European Football Associations (UEFA) expert group statement [12] also reported that the goalkeeper was the playing position with the highest values for height, weight, and FM.

In our work, in relation to goalkeeper height and weight, with the exception of one study [27], all show these characteristics [23,25,26,28–32,37,43,44,46–48,51,52]. Although the percentages of FM coincide in several studies [27,31,42,44,48,51], there are exceptions above [23,26,46,47,52] and below the range suggested by Ziv & Lidor [32,37,43,51]. Although the goalkeeper is often attributed as the position with the highest FM, as shown in Table 3, there were no statistically significant differences for both the percentage and weight of FM compared to the other playing positions. However, the sum of six skinfolds, which is correlated with FM, did show statistical differences, with the goalkeeper having the highest sum of skinfolds (58.8 mm). These results could be justified due to the fact that the goalkeeper, during training and especially in matches, in general, travels shorter distances than the rest of the playing positions, so it is reasonable that the goalkeeper is the playing position with the highest sum of skinfolds. In addition, due to their sporting role, they need to have a vertical jump and a developed wingspan in order to block the shots of the opposing team, which would justify the results obtained in relation to height, weight, and muscle mass [9,10,12,50].

In the case of the defenders, they appear to be in the position with the highest total weight and MM together with the goalkeepers. This makes sense because, due to their role in the game, it is a very physical position in which they must stop attackers by intercepting plays both on the ground and in the air and initiate offensive plays on many occasions. Midfielders are the shortest and lightest, as well as showing similar values to forwards in MM and FM. This body composition is justified in order to favor agility and speed during the game, especially in counter-attacking plays, being the main roles of midfielders and forwards (although this role may vary depending on the strategic alignment of the team, the coach's style of play, etc.) [2,3,8,53].

4.2. Somatotype Values

In relation to somatotype, Cavia et al. [16] analyzed the somatotype between playing positions, where goalkeepers (endomorphy 2.80 $\pm$ 0.60, mesomorphy 4.80 $\pm$ 1.30, and ectomorphy 2.30 $\pm$ 0.70) and forwards (endomorphy 2.10 $\pm$ 0.40, mesomorphy 4.50 $\pm$ 0.90, and ectomorphy 2.60 $\pm$ 0.90) presented a balanced mesomorphic somatotype similar to that described in other studies [54], while midfielders (endomorphy 2.20 $\pm$ 0.60, mesomorphy 4.30 $\pm$ 0.90, and ectomorphy 2.80 $\pm$ 0.60) and defenders (endomorphy 2.20 $\pm$ 0.40, mesomorphy 4.50 $\pm$ 0.50, and ectomorphy 2.90 $\pm$ 0.40) maintained an ecto-mesomorphic profile. However, in one of the studies included in our work, somatotype by playing position was also evaluated in a sample of 23 professional soccer players from the Italian league, although on this occasion, no significant differences were observed [34]. In our work, no significant differences were observed between the different playing positions, with mean values of endomorphy 2.31, mesomorphy 5.06, and ectomorphy 2.30, resulting in a balanced mesomorph somatotype, similar to the result obtained in the first study of our research group [17].

4.3. Models and Equations to Estimate Body Composition

All the methods to estimate body composition have advantages and defects, and sports-health professionals have to choose methods with a better benefit-to-cost ratio [55]. The anthropometric method is easy, inexpensive, easy to transport, and quick to apply. This method also has sufficient validity and reliability to be considered a useful tool in the assessment of FM in the athlete population [56], but the reliability can be affected by the error introduced by the researcher (varying between 3.0% and 11.0% between a trained/expert and untrained/expert researcher) [57,58]. One of the problems of the anthropometry method is the existence of multiple equations to estimate body composition, mainly FM [57,59]. Equations for estimating FM commonly assume a constant value for the density of FM and free FM [53,57]. While using a constant value for fat mass is generally accepted, free FM has been shown to be influenced by age, gender, and race, which introduces another potential source of bias [60,61]. Additionally, while several equations have been validated to estimate FM, only Kerr´s equation has been validated using a direct method, whereas the others were validated using indirect methods [62]. Therefore, it is possible that there may be errors in estimating FM using these equations. Kerr's equation allows the estimation of subcutaneous adipose tissue, which considers adipose tissue, including in its estimation of other non-lipid components (such as water and proteins) that are part of adipocytes [59,62].

Therefore, the use of the sum of skinfolds is effective, especially considering that other methods are affected by factors that are difficult to control and standardize, especially in the clinical setting, such as food intake, hydration levels, or daily physical activity [63,64].

Another problem is the level of fractionation of body composition used, specifically the adipose component. There is confusion in using the terms fat, lipids, and adiposity as synonyms when they are not [57]. There are five different levels to understanding how body mass is composed. The first model looks at the number of different atoms, including hydrogen, carbon, oxygen, nitrogen, calcium, phosphorus, and others. The second model considers body mass in terms of the different types of molecules it contains, including lipids, water, proteins, carbohydrates, and minerals. The third model takes into account the different types of matter that make up the body's cells, including fat, water, and solids. The fourth model looks at body mass in terms of different types of tissues, such as adipose tissue, muscle, bone, and connective tissue. Finally, the fifth model considers the body as a whole and breaks it down into different segments, such as the head, trunk, and limbs, to understand how mass is distributed throughout the body [57,59,65]. The anthropometric method is possible to approach adiposity using molecular and tissue models [53,57].

In conclusion, for the first time to our knowledge, it has been possible to establish indicative reference values for the different body compartments (Figure 3).

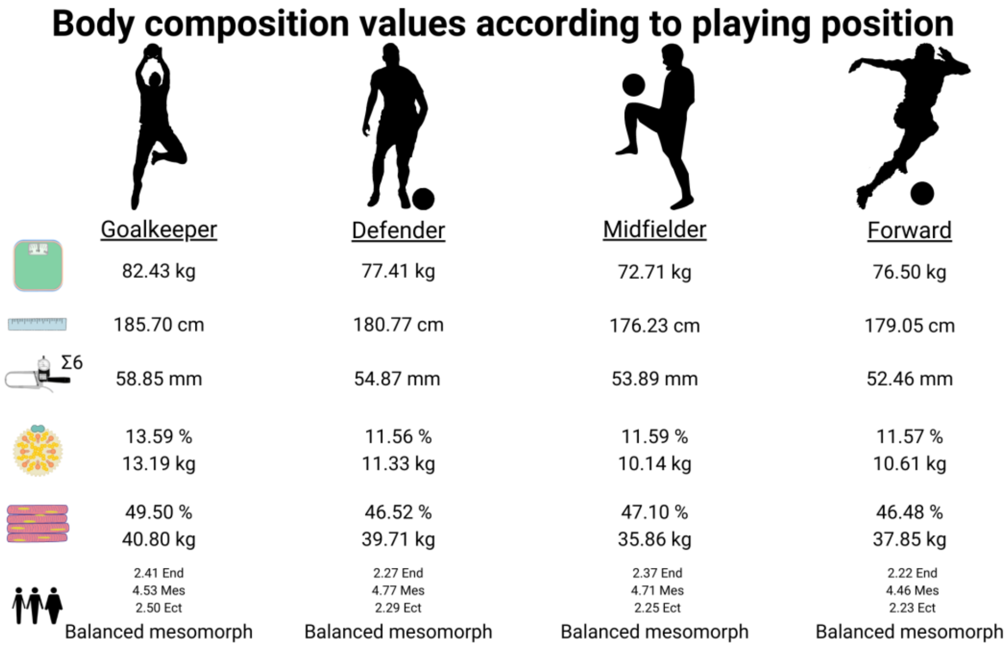

Figure 3. Body composition values differentiated by playing position (Weight, height, sum of six skinfolds (triceps, subscapular, supraspinal, abdominal, mid-thigh, and calf), fat mass percentage and kilograms, muscle mass percentage and kilograms, somatotype). End = endomorphy; Mes = mesomorphy; Ect = ectomorphy.

4.4. Limitations

This study has limitations. In the first place, the existing heterogeneity in the equations for estimating body composition using the anthropometric method, moments of the season in which the assessment is performed, playing positions, and measuring instruments to evaluate the different body components make it difficult to compare the results. In addition, not all the studies that used the anthropometric method detail the measurement protocol applied, so the methodology and evaluators could be biased. On the other hand, although for the anthropometry section, we excluded certain measurement instruments that were not valid for the ISAK protocol, we did not apply any limiting criteria for the BIA and DXA instruments. This is important since, for example, there is a risk of unifying tetrapolar and octapolar BIA values, as well as monofrequency and multifrequency. In addition, it would have been interesting to incorporate total body water data by playing position, but only one study or none described these body composition values. In a recent publication by the authors [17], the total body water values can be observed without differentiating by playing position. Another limitation is that, although data collection was limited to male professional soccer players, not all countries show the same soccer level, with some countries having higher Fédération Internationale de Football Association (FIFA) rankings than others [66]. Although it is true that they are all professional soccer players, they do not show the same degree of professionalism in terms of economic level, sports facilities, and physical demands, which could affect many factors that could influence their body composition and sports performance. Finally, due to the limited number of studies included, the body composition values of anthropometry, BIA, and DXA were unified. This may affect the usefulness of FM, MM, and FFM values, as body composition values obtained through the different measurement instruments do not always show a high correlation [53,57,67,68]. However, the usefulness of the sum of skinfolds and somatotype as values exclusive to anthropometry, BMC, and BMD as they are specific to DXA, and age, height, and total weight as parameters that do not require specific equations, do not show any limitation when using them as reference values.

Despite all this, it is the only study currently found in the scientific literature that provides a complete description of body composition differentiated by the different playing positions. Based on the current situation, our work aims to be the first study to suggest indicative ranges of anthropometric values, FM, MM, and BM, in detail in the different playing positions of men's professional soccer.

4.5. Future Research and Practical Application

The importance of assessing WM, BM, and body water and their relationship with sports performance has increased in recent years; studies continue to focus on total weight and FM. For future studies, it is recommended to (1) specifically describe the procedures, protocols, and variables applied when performing the measurements; (2) specify the reliability, calibration of the measuring instruments, and the technical error of measurement; (3) clearly control and report the state of hydration and nutrition before the measurement; (4) to indicate the competitive level of the sample by reporting the country and/or region and the competition league name at the time of the study; (5) report the playing position and the exact time of the season in which the measurements were taken; (6) show all the body composition characteristics of the different methods used, as well as the anthropometric and somatotype values; (7) to evaluate the body composition at the tissue level (fractionation in five components) at different times of the season; and (8) to characterize kinanthropometrically (heights, breadths, and lengths) according to the playing position.

All this will allow us to relate, compare, and differentiate the kinanthropometric profile of the player depending on the playing position, physical characteristics, level of competition, and sports performance.

5. Conclusions

This systematic review with meta-analysis provides useful information to help medical–technical staff to adequately assess the body composition of male professional soccer players, concluding that: (1) the goalkeeper is the playing position that shows the greatest height, age, total weight, sum of skinfolds, and MM; (2) defender is the position that shows the greatest age and MM (like goalkeepers); (3) the midfielder has shown to be the playing position with the lowest height, total weight, and MM; (4) the forwards seem to be the youngest, with the lowest sum of skinfolds and the lowest MM (like midfielders); (5) no significant differences were observed in BMC, BMD, somatotype, weight, and FM percentage.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/app13084782/s1, Table S1: Body composition characteristics of included studies with anthropometry by playing position; Table S2: Body composition characteristics of included studies with BIA by playing position; Table S3. Body composition characteristics of included studies with DXA by playing position; Figure S1. Forest plot of age according to playing position; Figure S2. Forest plot of height according to playing position; Figure S3. Forest plot of weight according to playing position; Figure S4. Forest plot of the sum of skinfold according to playing position; Figure S5. Forest plot of fat mass percentage according to playing position; Figure S6. Forest plot of fat mass kilograms according to playing position; Figure S7. Forest plot of muscle mass percentage according to playing position; Figure S8. Forest plot of muscle mass kilograms according to playing position; Figure S9. Forest plot of fat-free mass kilograms according to playing position; Figure S10. Forest plot of endomorphy according to playing position; Figure S11. Forest plot of mesomorphy according to playing position; Figure S12. Forest plot of ectomorphy according to playing position; Figure S13. Forest plot of bone mineral density according to playing position; Figure S14. Forest plot of bone mineral content according to playing position.

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Abbreviations

AHRQ: Agency for Health Research and Quality; ASRM: Anthropometric Standardization Reference Manual; BIA: Bioelectrical impedance; BM: Bone mass; BMC: Bone mineral content; BMD: Bone mineral density; DXA: Dual X-ray densitometry; FIFA: Fédération Internationale de Football Association; FFM: Fat-free mass; FM: Fat mass; IBP: International Biological Program; ISAK: International Society for the Advancement of Kinanthropometry; MM: Muscle mass; PICO: Population/Intervention/Comparison/Outcomes; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; REML: Restricted Maximum Likelihood; SATA: Sistema de Acreditación en Técnicas Antropométricas; UEFA: Union of European Football Associations.

Appendix A

Words and search strategy in PubMed: ("Soccer" [Mesh] OR "soccer player" [Title/Abstract] OR "fútbol" [Title/Abstract] OR "soccer" [Title/Abstract] OR "football" [Title/Abstract]) AND ("Anthropometry" [MeSH] OR "Anthropometry" [Title/Abstract] OR "Body composition" [MeSH] OR "Body composition" [Title/Abstract] OR "Skinfolds" [Title/Abstract] OR "Skinfold Thickness" [MeSH] OR "Somatotypes" [Mesh] OR "Somatotypes" [Title/Abstract] OR "Body Build" [Title/Abstract] OR "Body Type" [Title/Abstract] OR "Endomorph" [Title/Abstract] OR "Mesomorph" [Title/Abstract] OR "Ectomorph" [Title/Abstract] OR "Absorptiometry, Photon" [Mesh] OR "Absorptiometry, Photon" [Title/Abstract] OR "Electric Impedance" [Mesh] OR "Electric Impedance" [Title/Abstract] OR "Bioimpedance" [Title/Abstract] OR "DXA" [Title/Abstract] OR "Dual Energy X-ray Absorptiometry" [Title/Abstract]) NOT ("youth" [Title/Abstract] OR "young" [Title/Abstract] OR "semi-professional" [Title/Abstract] OR "amateur" [Title/Abstract] OR "collegiate" [Title/Abstract] OR "pre-adolescent" [Title/Abstract] OR "recreational" [Title/Abstract] OR "adolescent" [Title/Abstract] OR "junior" [Title/Abstract] OR "referee" [Title/Abstract] OR "referees" [Title/Abstract] OR "gaelic" [Title/Abstract] OR "rugby" [Title/Abstract] OR "american football" [Title/Abstract] OR "female" [Title/Abstract] OR "women" [Title/Abstract]) AND ("professional" [Title/Abstract] OR "elite" [Title/Abstract]).

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