

# Anthropometric profile and physical fitness of soccer referees from La Guajira, Colombia

## Perfil antropométrico y aptitud física de árbitros de fútbol de La Guajira, Colombia

González-Ortega, Jesús<sup>1</sup> 

López-Hernández, Ricardo<sup>1</sup> 

Sánchez-Puche, Everardo<sup>1</sup> 

<sup>1</sup> Universidad de La Guajira, Colombia

### Correspondence:

Jesús Alberto González-Ortega  
[jealgonor@uniguajira.edu.co](mailto:jealgonor@uniguajira.edu.co)

### Short title:

Anthropometric profile soccer referees

### How to cite this article:

González-Ortega, J., López-Hernández, R., & Sánchez-Puche, E. (2023). Anthropometric profile and physical fitness of soccer referees from La Guajira, Colombia. *Cultura, Ciencia y Deporte*, 18(57), 77-92. <https://doi.org/10.12800/ccd.v18i57.2019>

Received: 17 February 2023 / Accepted: 18 April 2023

## Abstract

The role of soccer referee requires physical preparation and body composition that meet the physical demands of the sport. In this sense, as soccer is becoming increasingly demanding every day, referees must be able to meet these new challenges. This study describes the anthropometric profile and physical condition of Colombian soccer referees in order to design training plans based on scientific and methodological criteria. For this, nine soccer referees aged  $23.3 \pm 5.04$  years participated in a non-experimental study that was descriptive in nature and followed a quantitative approach. Body mass index, body fat percentage, muscle mass and physical condition were analyzed using physical tests proposed by FIFA (6x40 m, yo-yo, CODA, 5x30 acceleration and ARIET). Results are expressed as means, standard deviations, and minimum and maximum values. Findings show that a body mass index of  $22.19 \pm 2.58$  corresponded to a normal score. Somatochart outcomes reveal the group to be meso-endomorphs with a fat mass of  $11.8 \pm 1.8$  and a muscle mass of  $38.19 \pm 3.06$ . Tests revealed referees to be, generally, in excellent physical condition, with the exception of the dynamic yo-yo test.

**Keywords:** Referees, anthropometric profile, physical fitness, La Guajira referees.

## Resumen

El papel del árbitro de fútbol exige de una preparación física y composición corporal acordes con las exigencias físicas del deporte. Por ello, así como el fútbol cada día es más exigente, los árbitros deben estar en condiciones de dar respuestas a las mismas. Este estudio describe el perfil antropométrico y la condición física de árbitros de fútbol colombianos para establecer planes de entrenamiento con criterio científico y metodológico. Para ello, participaron nueve árbitros de fútbol con  $23.3 \pm 5.04$  años, se seleccionó un estudio no experimental de tipo descriptivo con enfoque cuantitativo. Se analizaron el índice de masa corporal, porcentaje de masa grasa, masa muscular y la condición física con las pruebas físicas propuestas por la FIFA (6x40 m, yo-yo, Coda, aceleración 5x30 y Ariet). Los resultados se expresan en media, desviación estándar, valores mínimos y máximos. Los hallazgos evidencian un índice de masa corporal de  $22.19 \pm 2.58$  para una calificación normal, los resultados de la somatocarta ubican al grupo como meso-endomorfos con una masa grasa de  $11.8 \pm 1.8$  y de masa muscular de  $38.19 \pm 3.06$ . La condición física de los árbitros se encuentra en condiciones excelentes, excepto en la prueba yo-yo dinámico.

**Palabras clave:** Árbitros, perfil antropométrico, aptitud física, árbitros guajira.



This work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.

## Introduction

The evolution of soccer has led to the modern brand of soccer watched in the present day. This is reflected every day on the pitch where, accompanied with an array of technology, players with extensive physical abilities compete, demonstrating that engagement in this sport places ever increasing demands and requires ever increasing discipline. The aforementioned is easily corroborated. National and international competitions exhibit that “contemporary players take on multifunctional roles given that, during a match, they tackle both offensive and defensive situations and contribute to the actions of their teammates in other playing positions” (González, 2014, p. 1). Thus, this situation brings with it the need for a physical preparation that meets the demands presented on the field of play, such as short-duration sprints, high-intensity runs, jumps, duels, changes of direction and standing episodes, with average play intensity ranging from 80 to 90% of maximum heart rate (HRmax), (Saeidi, 2017, cited in Vasquez et al., 2021, p. 216)

Seen in another way, soccer as a spectacle sport has always been subject to compliance with regulations on the field of play. Further, players must adhere to these regulations under the direction of referees who are responsible for supervising the application of the rules of the game during matches (Castagna & D'Ottavio, 2001). As part of the arbitration exercise, “every week, approximately 1.3 million referees worldwide participate in soccer matches to regulate and control compliance with the rules of the game” (Yanci, 2014, p. 337). Nevertheless, to meet the demands of refereeing, strong physical preparation, in addition to psychological and theoretical training, is essential to handle the different situations that arise on the pitch.

Various authors (Barbero et al., 2012; Castillo et al., 2015; Mallo, 2006; Rivera & Naranjo, 2016) agree on the importance of the role of referees on the pitch, acknowledging that they must be in an optimal physical condition to be able to make displacements, change direction, sprint and be as close as possible to the different actions that occur on the pitch. According to Mellalieu et al. (2006) and Muñoz and Castillo (2020), it should be noted that “soccer referees are a fundamental piece in the correct performance of the competition, which has led to the interest of the scientific community in recent decades” (Cited in Muñoz et al., 2022, p. 42)

Further, several authors (Palma, 2014; Vacacela & Moscoso, 2021) agree that, in addition to good physical preparation, soccer referees should consider body composition as a crucial variable pertaining to their preparation. Besides, it is acknowledged that, as a result of engaging in such a demanding exercise, referees are valued as athletes or, even, as another player, since they spend a lot of time preparing their bodies to withstand great efforts during short periods (Bustamante, 2014).

From this perspective, Kinanthropometry is defined as the use of measurements in the study of the size, shape, proportionality, composition and maturation of the human body, all of which may vary as a function of growth, physical activity and nutritional stage (Ross, 1991). Thus, the study, application and development of Kinanthropometry are not typical of a single scientific discipline. Instead, it involves knowledge of various areas that use the tools of Kinanthropometry given their usefulness in areas such as the evaluation of nutritional status, management and evaluation of sports training, study and analysis of the somatochart, and study of body proportionality (Riaza et al., 1993).

Likewise, the anthropometric characteristics of individuals reflect their shape, proportionality and body composition (Quintana, 2005). Thus, evaluation of the five body components or fractionation of human body mass (Kerr et al., 2007), together with somatotype assessments (Carter, 2007), allow for more in-depth understanding of individuals and, consequently, better selection and orientation of athletes in the search for optimal performance (Herrero et al., 2009, cited in Clavijo et al., 2016, p. 630).

In this sense, the measurement of anthropometric variables can favor better targeting or planning when it comes to physical training (Herdy et al., 2016, cited in Vacacela & Moscoso, 2021, p. 673). For this reason, the present research aims to examine the fat percentage, muscle mass and physical condition of soccer referees in La Guajira. The purpose of this is to design training plans based on scientific criteria that are more in line with the demands of the arbitration exercise.

## Methodology

The present research is descriptive, non-experimental and quantitative in nature. The study was conducted with soccer referees from the department of La Guajira, Colombia. All referees were categorized by the Colombian professional soccer arbitration commission as B or C level referees. The sample consisted of nine referees with an average age of  $23.67 \pm 5.12$  years, of which 22.2% were full referees and 77.8% were assistants (Table 1). The sample was selected intentionally in line with criteria established by Castro (2003) who states that “if the population corresponds to fewer than fifty (50) individuals, the population and the sample are the same”.

Information was collected in line with International Society for the Advancement of the Kinanthropometry (ISAK) protocols by a certified Level 2 anthropometrist. Likewise, data collection was supported by an ISAK level 1 certified assistant, who helped the evaluator to record variables in an electronic spreadsheet. Average technical measurement error for the evaluated variables was 1%. With regards to the fitness tests proposed by the International Football Federation and Associates (FIFA),

the referees' personal coaches administered all tests. Anthropometric measurements and the evaluation of the physical condition were carried out in a sports hall. The two types of tests were performed on two different days.

Body mass index was calculated as the ratio of weight/height<sup>2</sup> (kg/m<sup>2</sup>). In order to establish this variable, objectively established values measured from a bioimpedance calibrated scale were used (Carvajal et al., 2018) (Full body sensor, body composition monitor and scale with standardized dry wall millimeter: model BC-585F, FitScan). Adipose tissue percentage was calculated from skinfold measurements (Sánchez et al., 2014). For fat mass percentage, a Slim Guide fold calibrator was used, with an accuracy of 0.5 mm. The formula proposed by Yuhasz (cited by Alba, 2005) was applied to calculate outcomes, where  $[0.1051 \times \sum \text{kinfolds}] + 2.585$ . Muscle mass percentage calculations were estimated from the sum of perimeters (relaxed arm, forearms, thorax, thigh and leg), for which, the following calculation was used: % MM = [(mass kg x 100/weight kg)].

With regards to somatotype, possible classifications have been outlined by Carter (2002). These corresponded to a previously developed somatochart, as proposed by Carter and Heath (1990), in which relevant coordinates are calculated, plotted and perused to establish the extent of the endomorphic, mesomorphic and ectomorphic components. In this sense, somatotype refers to the general shape or appearance of individuals, with genetic factors playing a central role. It is determined by the amount of muscle and fat found in the body, in addition to the linearity of the different body parts. Accordingly, it is calculated from measures of adiposity, muscle mass and bone mass, whilst also considering height and weight at the time of calculation (Arias, 2019).

Finally, tests proposed by the International Football Federation and Associates for assessing the physical condition of referees and assistant referees were administered (change of direction [CODA], 5x30 repeated sprint ability, intermittent endurance [ARIET], 6x40 m repeated sprint ability, intermittent yo-yo level I).

All data were statistically analyzed using the statistical software SPSS, version 25. Descriptive analysis was conducted in order to calculate means, standard deviations and frequencies for all studied variables. Finally, the participation of all referees was voluntary. All participants were informed of the research objectives and provided written informed consent in accordance with the guidelines set out in the Declaration of Helsinki (2013). The study was reviewed and approved by the Ethics Committee of the University of La Guajira.

## Results

### Anthropometric profile

Outcomes presented in Table 1 pertain to data collected regarding the age, weight, height and body mass index of participating soccer referees from La Guajira. As can be observed, the group under study had an average age of  $23.67 \pm 5.12$  years. In addition, average weight was  $63.70 \pm 9.66$  kg, with a maximum weight of 75 kg and a minimum weight of 48 kg. With regards to height, an average measurement of  $167.33 \pm 5.32$  cm was produced, whilst body mass index was  $22.19 \pm 2.58$ , with a minimum value of 17.6 and a maximum value of 25.7. This meant that the present group, in general, could be classified as having a healthy body mass index.

**Table 1.** Age, height, weight, BMI

	Age	Weight (kg)	Height (cm)	BMI
Mean	23.67	63.70	167.33	22.19
Std. Dev	5.12	9.66	5.32	2.58
Minimum	16	48	158	17.6
Maximum	30	75	174	25.7

Legend: BMI = body mass index; Std. Dev = standard deviation.

Sociodemographic characteristics are presented in Table 2. With regards to sex, it can be observed that 88.9% belonged to the male sex and 11.1% belonged to the female sex. Likewise, 100% of referees were undertaking or had already completed university studies. Turning attention to

function on the field of play, 22.2% acted as main referees, whilst 77.8% were assistant referees. In addition, 22.2% belonged to socioeconomic stratum III and another 77.8% belonged to stratum II.

**Table 2.** Sociodemographic characteristics

Gender	%	Studies	%	Role	%	Stratum	%
Male	88.9	University	100	Full referee	22.2	II	77.8
Female	11.1			Assistant	77.8	III	22.2

Review of data gathered to measure the body mass index of soccer referees from the department of La Guajira, reveals that 11.1% are underweight, whilst 66.7% have an

average weight and 22.2% have type I obesity, according to the classification of the World Health Organization (WHO).

**Table 3.** Body mass index

	BMI (kg/m <sup>2</sup> )	Classification	%
Mean	22.19	Underweight	11.1
Std. Dev	2.58	Normal	66.7
Minimum	17.6	Type I obesity	22.2
Maximum	25.7		

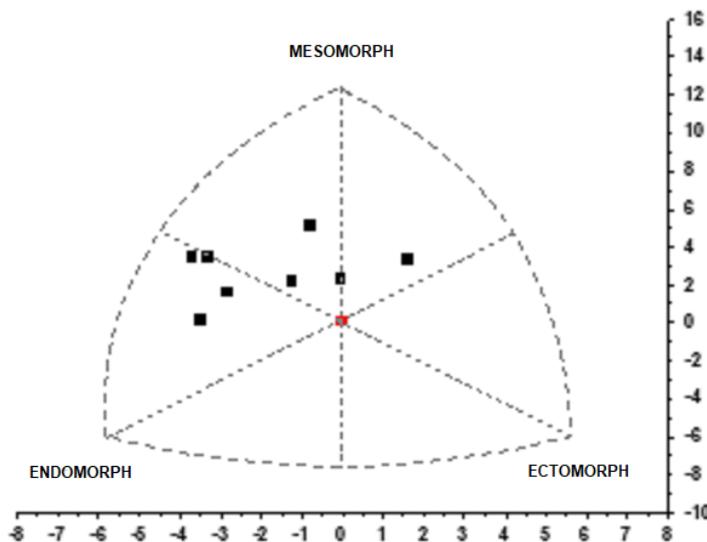
Turning attention to body shape data, the somatotype of the sample under study was classified by averaging relevant outcomes (Table 4). From this, outcomes produced for the studied group were plotted on a somatochart. From this, it

could be seen that an average of 4.19 ± 1.18 individuals are classified as being meso-morphic, with 4.03 being endo-morphic and 2.36 being ecto-morphic.

**Table 4.** Somatotype

	Endomorph	Mesomorph	Ectomorph
Mean	4.03	4.19	2.36
Std. Dev	0.72	1.18	1.23
Minimum	3.0	2.5	1.0
Maximum	5.0	5.8	4.7

Legend: Std. Dev = standard deviation.



**Figure 1.** Somatochart for full and assistant referees

From examination of the outcomes presented in Table 5, it can be inferred that the referees under study had an average fat mass of 11.8% ± 1.8%. In this sense, the lowest

fat mass recorded in the present study was 9.4%, whilst the highest was 14.8%.

**Table 5.** Fat and muscle mass

	Fat mass	Muscle mass
	%	%
Mean	11.8	38.19
Std. Dev	1.8	3.06
Minimum	9.4	32.91
Maximum	14.8	43.21

Legend: Std. Dev = standard deviation.

Finally, with regards to outcomes from this section, outcomes pertaining to muscle mass in participating soccer referees from the department of La Guajira revealed an average of  $38.19\% \pm 3.06\%$ . Within this category, the minimum value found was  $32.91\%$ , whilst the maximum was  $43.21\%$ .

### Physical condition

In order to examine the physical condition of participating soccer referees from La Guajira, physical tests recommended by the International Federation of Football and Associates (FIFA) were administered. It is important to bear in mind that these tests are carried out semiannually in order to track the physical condition of referees throughout the country. They are deemed

essential given that a referee's physical condition will be a huge factor, alongside their performance during matches, in them being requested to officiate at any of the various national tournaments.

In consideration of that discussed above, physical condition plays a significant role in refereeing. When a referee obtains a good rating following their performance during a match, they are attributed points which increase their likelihood of being called to officiate future matches during the season. Assistant referees are evaluated using different physical tests to those administered to full referees in order for tests to better target the functions performed on the pitch.

**Table 6.** Assistant referees – physical condition

	<b>CODA (11 Sec)</b>	<b>Sprint (5x30 m)</b>	<b>Ariet (shuttles)</b>	<b>Ariet (meters)</b>
Mean	9.47	4.23	14.88	1141.67
Std. Dev	0.24	0.17	0.94	258
Maximum	9.88	4.48	16.4	1495
Minimum	9.22	3.99	13.5	715

Legend: Std. Dev = standard deviation.

CODA test outcomes, which seeks to evaluate power, explosive force and the ability to change direction in assistant referees, produced an average speed of  $9.47 \pm 0.24$  sec within the group as a whole. As seen in Table 7, participating assistant referees performed excellently, with balanced outcomes also being demonstrated via the standard deviation. Specifically, only 0.24 sec differentiated the best and worst performers. Further, it is also worthy to mention that the maximum time required by a Colombian soccer assistant referee to complete this test was 11 sec.

Turning attention to the sprint ability test (5x30), which aims to measure assistant referees' ability to perform repeated sprints against the clock, an average speed of

$4.23 \pm 0.17$  sec was produced. This outcome is considered as a function of standards set by the Colombian arbitration commission, which allows a maximum time of 5.10 sec. Thus, it can be inferred that those evaluated have excellent sprint ability.

Likewise, the Ariet test or intermittent resistance test shows, in general, that assistant referees have a below expected level (Table 6). Participants completed an average of 14.88 shuttles, covering a total of 1141 m. From this, performance of the present group as a whole is classified as average. More specifically, the performance of 44% of participating assistant referees could be classified as excellent, 44.4% as fair and 11.1% as bad.

**Table 7.** Full referees – physical condition

	<b>6x40 m</b>	<b>Dynamic Yo-Yo</b>	<b>VO<sup>2</sup> Max (ml/kg/min)</b>
Mean	5.31	15.2	43.85
Std. Dev	0.16	0.93	2.02
Maximum	5.47	15.6	44.8
Minimum	5.07	13.3	39.76

Legend: Vo2 Max = maximum oxygen uptake; Std. Dev = standard deviation.

With regards to the tests administered to main referees (Table 7), repeated sprint (4x40 m) was measured first, producing an overall mean group time of  $5.31 \pm 0.16$  sec. The time limit set by the arbitration committee to be classified as eligible to receive a call at national level is 6.10 sec. Thus, from this outcome it can be inferred that full

referees from the department of La Guajira are in excellent physical condition.

The dynamic yo-yo or intermittent resistance test for full referees seeks, in addition to measuring ability to recover from intermittent progressive efforts, to measure

displacement with the aim being to travel as much as possible. On average, the group completed  $15.2 \pm 0.93$  shuttles, covering a distance of 840 m. In addition, maximum oxygen consumption ( $VO_2$  max) was also measured in full referees, producing an average of  $43.85 \pm 0.02$  ml/kg/min.

When analyzing the results obtained by full referees in this test, we can show that they covered an average total distance of 973 m, a distance that corresponds to 15.5 shuttles and would earn them an average rating. The arbitration commission recommends that referees be able to complete 18.5 shuttles (1920 m). However, when looking in more detail, 83.3% of participating referees obtained a fair rating, whilst 16.7% obtained a poor rating.

## Discussion

Following an examination of the outcomes, a number of inferences can be made. The present study was conducted with a sample with an average age of  $23.3 \pm 5.04$  years, being younger than the sample of Brazilian referees ( $37.6 \pm 4.2$  years) recruited by Da Silva et al. (2012) and similar to the sample of Colombian ( $24.7 \pm 3.5$  years) and Mexican ( $24.28 \pm 3.52$  years) officials recruited by Palma (2014) López et al. (2021), respectively.

With regards to the body mass index classifications given to the referees evaluated in the present study, an average value of  $22.19 \pm 2.58$  was produced. This is lower than that found in studies carried out by Palma (2014) ( $23.42 \pm 2.12$ ); Castillo et al. (2019) ( $22.8 \pm 1.4$ ); Vacacela and Moscoso (2021) ( $23.76 \pm 1.26$ ); and López et al. (2021) ( $24.04 \pm 2.88$ ).

In consideration of the somatotype classification of participating soccer referees from La Guajira, overall outcomes define 44.4% as meso-endomorphs ( $4.19 \pm 1.08$ ). This is in accordance with outcomes reported by authors such as Da Silva et al. (2012) in Brazilian officials ( $4.0 \pm 1.4$  and  $4.0 \pm 0.8$ ) and López et al. (2021) in Uruguayan referees ( $4.1 \pm 1.13$ ). It could also be seen that 33% of the sample corresponded to an average somatotype score of  $4.03 \pm 0.72$ , leading them to be classified as endo-mesomorphs. This is in accordance with classification outcomes reported by Palma (2014) who revealed values of  $4.2 \pm 1.2$ . Finally, 11.1% were classified as ecto-endomorphs ( $2.36 \pm 1.26$ ), with this finding not being similar to any previously reported outcome. Table 4 presents sample distribution according to somatotype.

When examining outcomes pertaining to the fat mass percentage of examined referees, values higher than those reported in previously conducted studies emerged (Casajus & Castagna, 2007). On the other hand, the group average was  $11.8 \pm 1.8$ , with this being lower than those reported by authors such as Fernández et al. (2008); Da Silva et al. (2012); Palma (2014); Yanci et al. (2014); Castillo et al. (2019); López et al. (2021); and Vacacela and Moscoso (2021).

Further, muscle mass outcomes pertaining to soccer referees from the department of La Guajira revealed

an average muscle mass of  $38.19\% \pm 3.06\%$ . Within this analyzed group, the lowest muscle mass was found to be 32.91%, whilst 43.21% was found to be the highest muscle mass. Of the studies reviewed, Da Silva et al. (2012) found a higher muscle mass than that reported for officials in the present study, with an average of 42.4% in full referees.

Likewise, physical condition outcomes were positive and indicated a high performance level in soccer referees from La Guajira. Of all of the tests carried out with full referees and assistant referees (Table 6 and Table 7), the test that produced the least favorable outcomes was the yoyo-dynamic test which is administered only to full referees. Further,  $VO_2$ max was calculated from data produced from this test, suggesting that participating referees had an average  $VO_2$ max of  $43.85 \pm 2.02$  ml/kg/min. This outcome is lower than that produced in studies conducted by Casajus and Castagna (2007) and Yancy et al. (2014) with Spanish referees, however, it is similar to findings reported by Castagna and D'Ottavio (2001) and Krustup and Bangsbo (2001).

In this sense, data collected from full referees show that 83.3% and 16.7% have good and moderate maximum oxygenic capacity, respectively.

## Conclusions

The anthropometric profile, including variables such as weight-height ratio, body composition and somatotype is considered to provide relevant information about the human body and its characteristics. However, it is essential to remember that there are other variables to consider when assessing a soccer referee and deciding whether they are capable of adequately performing their function (Palma, 2014).

From this perspective, the present study reveals that soccer referees from La Guajira have a body mass index, fat mass, muscle mass and physical condition that are similar to or below that seen in work carried out by authors mentioned above. This denotes the variety of somatotype profiles found in different regions of the world, where the role and importance of the performance of soccer referees has become a matter of serious interest.

Thus, it is necessary to conduct more studies related to the assessment of the different capacities and conditions in soccer referees. Such research would facilitate further comparisons and more in-depth understanding of variables related to the improvement of performance in all of the settings in which they work. From this, it would also be possible to propose more informed preparation plans based on scientific and methodological criteria.

Finally, it is worth mentioning that the emergence of different outcomes in comparison to previously conducted studies may be related to the fact that referees from La Guajira are typically younger and less experienced at officiating than the referees recruited to the other studies

mentioned here. Another factor may be the different protocols followed by the administered tests.

## Bibliography

- Alba Berdeal, A. L. (2005). *Test funcionales: antropometría y prescripción del entrenamiento en el deporte y la actividad física*. Editorial kinesis.
- Barbero-Alvarez, J. C.; Boulosa, D. A.; Nakamura, F. Y.; Andrin, G., & Castagna, C. (2012). Physical and physiological demands of field and assistant soccer referees during America`s Cup. *Journal of Strength and Conditioning Research*, 26(5), 1383-1388. <https://doi.org/10.1519/JSC.0b013e31825183c5>
- Bustamante, J. (17 de octubre de 2014). Preparación física del árbitro. *Blog fútbol Decathlon*. <http://blog.futbol.decathlon.es/preparacion-fisica-del-arbitro/>
- Carter, L. (1985). Factores morfológicos que limitan el rendimiento humano. *PubliCE Standard*, 1-12.
- Carvajal, W., Ríos, A., Echevarría, I., Martínez, M., Miñoso, J., & Rodríguez, D. (2009). Body type and performance of elite Cuban baseball players. *Medicc Review*, 11(2), 15-20. <https://doi.org/10.37757/MR2009V11.N2.6>
- Casajus, J. A., & Castagna, C. (2007). Aerobic fitness and field test performance in elite Spanish soccer referees of different ages. *Journal of Science and Medicine In Sport*, 10(6), 382-389. <https://doi.org/10.1016/j.jsams.2006.08.004>
- Castagna, C., & D´Ottavio, S. (2001). Effect of maximal aerobic power on match performance in elite soccer referees. *Journal of Strength and Conditioning Research*, 15(4), 420-425. <https://doi.org/10.1519/00124278-200111000-00004>
- Castillo, D., Cámara, J., & Yanci, J. (2016). Análisis de las respuestas físicas y fisiológicas de árbitros y árbitros asistentes de fútbol durante partidos oficiales de Tercera División de España. *RICYDE. Revista Internacional de Ciencias del Deporte*, 12(45), 250-261. <http://doi.org/10.5232/ricyde2016.04503>
- Castillo, D., Cámara, J., & Yanci, J. (2019). Efecto de un periodo competitivo sobre el perfil antropométrico de árbitros de fútbol. *Revista Internacional de Medicina y Ciencias de la Actividad Física y del Deporte*, 19(73), 93-105. <https://doi.org/10.15366/rimcafd2019.73.007>
- Castro, M. (2003). *El proyecto de investigación y su esquema de elaboración*. (2ª ed.). Uyapal.
- Clavijo-Redondo, A, Vaquero-Cristobal, R., López-Miñarro, P., & Esparza-Ríos, F. (2016). Características cineantropométricas de los jugadores de béisbol de élite. *Nutrición Hospitalaria*, 33(3), 629-636. [https://scielo.isciii.es/pdf/nh/v33n3/19\\_original18.pdf](https://scielo.isciii.es/pdf/nh/v33n3/19_original18.pdf)
- Da Silva, A. I. (2011). Somatotype and Physical Fitness of the Assistant Referees in Soccer. *International Journal of Morphology*, 29(3), 792-798. <https://doi.org/10.4067/S0717-95022011000300020>
- Da Silva, A. I., de los Santos, H., & Cabrera, C. (2012). Comparative Analysis of Body Composition of Football (Soccer) Referees from Brazil and Uruguay. *International Journal of Morphology*, 30(3), 877-882. <https://doi.org/10.4067/S0717-95022012000300019>
- Fernández Vargas, G. E., Inácio da Silva, A., & Arruda, M. (2008). Perfil Antropométrico y Aptitud Física de Árbitros del Fútbol Profesional Chileno. *International Journal of Morphology*, 26(4), 897-904. <https://doi.org/10.4067/S0717-95022008000400019>
- González, J. (2014). *Propuesta para el perfeccionamiento de la preparación física de los futbolistas prejuveniles (14-16 años) del club Guajiros Junior del municipio de Riohacha, la Guajira*. [Tesis de maestría], Universidad de Ciencias de la Cultura Física y el Deporte "Manuel Fajardo". <https://doi.org/10.13140/RG.2.2.29615.66722>
- Herrero de Lucas A, Esparza-Ros F, Cabañas-Armasilla M. (2009) *Características cineantropométricas de los deportes olímpicos de verano*. CTO Editorial.
- Kerr, D. A., Ross, W. D., Norton, K., Hume, P., Kagawa, M., & Ackland, T.R. (2007). Olympic lightweight and open-class rowers possess distinctive physical and proportionality characteristics. *Journal of Sports Sciences*, 25(1), 43-53. <https://doi.org/10.1080/02640410600812179>
- Krustrup, P., & Bangsbo, J. (2001). Physiological demands of top-class soccer refereeing in relation to physical capacity: effect of intense intermittent exercise training. *Journal of Sports Sciences*, 19, 881-891. <https://doi.org/10.1080/026404101753113831>
- López-García, R., Lagunes-Carrasco, J. O., Carranza-García, L. E., Ródenas-Cuenca, L. T., & Morales-Corral, P. G. (2021). Características morfológicas en árbitros de fútbol profesional en México; antropometría y DEXA. *Revista Internacional de Medicina y Ciencias de la Actividad Física y del Deporte*, 21(81), 117-129. <https://doi.org/10.15366/rimcafd2021.81.008>
- Mallo, J. (2006). *Análisis del rendimiento físico de los árbitros y árbitros asistentes durante la competición en el fútbol*. [Tesis Doctoral, Universidad Politécnica de Madrid]. <http://oa.upm.es/447/>
- Palma-Pulido, L. H. (2014). Análisis descriptivo del perfil antropométrico de árbitros de fútbol. *Revista de Entrenamiento Deportivo*, 28(1). [https://www.researchgate.net/publication/291356835\\_Analisis\\_descriptivo\\_del\\_perfil\\_antropometrico\\_dearbitros\\_de\\_futbol](https://www.researchgate.net/publication/291356835_Analisis_descriptivo_del_perfil_antropometrico_dearbitros_de_futbol)
- Quintana Sillero, M. (2005). *Teoría de kineantropometría*. INEF.
- Riaza, L. M., Fideu, M. D., & López, V. (1993). Estudio cineantropométrico en 58 ciclistas de competición.

*Archivos de Medicina del Deporte*, 10(38), 121-125.

[http://femedede.es/documentos/Cineantropometria\\_ciclismo\\_121\\_38.pdf](http://femedede.es/documentos/Cineantropometria_ciclismo_121_38.pdf)

Rivera, O., & Naranjo, C. (2016). Referee Trainer, app de soporte a la preparación física de árbitros de fútbol: Estudio de viabilidad. *Journal of Sports Economics & Management*, 6(3), 163-170. <https://idus.us.es/bitstream/handle/11441/70010/62-288-1-PB.pdf>

Sous-Sánchez, J., Ruiz-Caballero, J., & Brito-Ojeda, M. (2010). Valores ergoespirométricos en árbitros de fútbol de canarias. *International Journal of Medicine and Science of Physical Activity and Sport*, 10(39), 428-438. <http://cdeporte.rediris.es/revista/revista39/artvalores172.htm>

Vacacela-García, D. A., & Moscoso-García, R. F. (2021). Análisis de perfiles metabólicos en árbitros de fútbol profesional del Ecuador. *Revista Arbitrada Interdisciplinaria Koinonía*, 6(2), 669-685. <http://dx.doi.org/10.35381/r.k.v6i2.1259>

Weston, M., & Brewer, J. (2002). A study of the physiological demands of soccer refereeing. *Journal of Sports Sciences*, 20, 59-60. <https://doi.org/10.1080/026404102317126164>

Vázquez-Bonilla, A., Brazo-Sayavera, J., Timon, R., & Olcina, G., (2021). Measurement of resting muscle oxygenation and the relationship with countermovement jumps and body composition in soccer players. *Cultura, Ciencia y Deporte*, 16(48), 215-223. <http://dx.doi.org/10.12800/ccd.v16i48.1726>

Yanci-Irigoyen, J. (2014). Cambios en la condición física de árbitros de fútbol: un estudio longitudinal. *RICYDE. Revista Internacional de Ciencias del Deporte*, 38(10). <http://dx.doi.org/10.5232/ricyde2014.03804>

Yanci-Irigoyen, J., Reina-Vaillo, R., Granados-Domínguez, C., Salinero-Martin, J., & Los Arcos-Larumbe, A. (2014). Valoración y relación de las características antropométricas y la condición física en árbitros de fútbol. *Revista Española de Educación Física y Deportes*, (406), 15-27. <https://www.reefd.es/index.php/reefd/article/view/23/25>