Introduction

Kineanthropometry is a scientific specialty that measures the size, shape, proportions, composition, maturation and gross function of the body structure, applied in studies related to growth, development, nutrition, exercise, and especially sports performance (Ross et al., 1991). A more up-to-date definition considers this scientific discipline as the area of science in charge of measuring the composition of the human body, which constitutes the union between anatomy and movement to determine the capacity for function in a wide range of areas (ISAK, 2025).

Knowing the anthropometric characteristics of an athlete is essential to make decisions that will help improve their performance, constituting a valid and precise method to be able to make comparisons between athletes of different levels and to monitor the changes produced by training in body composition (Zaccagni et al., 2019). These morphological parameters are an essential part of the evaluation and selection of athletes, since they allow to determine the physical evolution of the player from an early age, which helps greatly in the intervention of the same.

Because there are different positions on the playing field, it is expected that there will be statistically significant differences in physiological and anthropometric characteristics. Therefore, the data obtained from studies on anthropometric and physiological characteristics give coaches the opportunity to perform specific training for the requirements that influence each player according to their specialization (Salazar et al., 2017).

The differences in the anthropometric profile of each player will determine the performance and performance for their mobility on the playing field, being able to identify that a goalkeeper does not have the same physical characteristics as a center camper, so the physical work, technical, tactical and nutritional must be differentiated according to each individual (Salazar et al., 2017; Fernández et al., 2017). It has also been shown that goalkeepers have a tendency to accumulate more adipose tissue in certain areas of the body, while midfielders and forwardsectomorphic, because the physical performance of the playing position conditions a greater type of fast fibers and muscle mass gain (López et al., 2019).

Professional footballers cover total distances between 10 and 13 km per match, while the average running intensity is close to the anaerobic threshold, requiring high levels of endurance, speed, strength and coordination skills. In this sense, muscle mass benefits power and speed, especially in the one-on-one game by giving an advantage to the strongest player, besides weight, height, muscle area of the thigh and calf positively influence this same capacity (Rodríguez, 2019). It is considered that an optimal body composition accompanied by technical skills promotes a higher level of sports performance (Salazar, 2017).

In this sense, scientific evidence has been accumulating in Cuba since the 1980s. At that time Rodríguez (1987) designed a reference guide which constituted a working tool that

aimed to support the Medical Control of Sports Training. The design of this training was based on the need to have an instrument that would make it possible to evaluate the achievement of the physical objectives of the training. Subsequently Carvajal and Deturnell (2017) designed a reference guide that met the same objectives of the previous study, as this no longer had the same value it had for almost 20 years. The design of the requirements took into account all athletes who made national shortlists in the period from the Sydney Olympics to the London 2012 Olympic Cycle. These are the standards that are currently used in the medical - sports control Cuban.

After the opening of the specialty of Sports Medicine in Villa Clara in 2013, a line of research related to the study of the body composition of villaclareños athletes was developed (Collazo Cruz et al., 2021; Hernández Moreno et al., 2023), However, research on footballers has not been disclosed despite the remarkable football tradition of the province, supported by the results in national championships, which has won in 14 editions.

Taking into account the elements described, a problematic situation is detected by the existence of regulations for the morphological evaluation of footballers with an age of more than 10 years. In addition, these rules are general based on data obtained from elite athletes throughout the country, so they do not have a specific character of a particular geographical area. In this sense, the villaclarense footballers may have morphological characteristics that differentiate them from others (Carvajal and Deturnell, 2017).

In relation to the above, it is established as a research objective to determine the characteristics of the body composition of high-performance Villavicano footballers in the period from October 2016 to December 2020 during the preparatory stage of the national championship.

Methodology

A retrospective longitudinal descriptive study was conducted with high-performance male footballers from Villa Clara. The measurements carried out at the beginning of the preparatory stage for each national championship held between 2016 and 2020 in Cuba were taken into account.

Population and sample

The population was made up of all members of male football teams in the social category of Villa Clara (n=51), where 3.9% participated in four years, 19.6% in three years, 39.2% in two years and 37.2% in one year. The average age was 22.4 years and sports experience 10.9 years.

Methods, techniques and procedures

The primary data were extracted from the medical and sports history to determine the age of the players and their sporting experience. In addition, the kineanthropometric data sheets of each athlete were used to extract data on body composition (weight, height, % fat, kg fat, active body mass and AKS). The indicators of body composition were determined as follows by the technicians of the Kineanthropometry laboratory:

For the calculation of body fat percentage (%CG) we used Withers et al., (1988):

$$\%GC=\frac{495}{1{,}10326-0{,}00031(edad)-0{,}00036(PSE+PTR+PSI+PPU+PMM+PPM)}-450$$

Nomenclature: - PSE: Subscapular Fold. - PMM: Middle Leg Fold.

- PTR: Tricipital fold. - PPM: Middle leg fold.
- PSIA: Suprailac fold. - ED: Decimal Age.
- PAB: Abdominal fold. - S6 Plg.: Summation of 6 folds

Once the percentage of fat was determined, proceed as follows:

- ✓ The following equation was used to determine the kg of fat.

  $$\text{kg of fat} = \frac{\%\text{ fat x body weight on scale}}{100}$$

- ✓ Active body mass (MAC) was determined by subtracting the kg of fat from the body weight on the scale.
- ✓ In determining the Active Body Substance Index (AKS) the formula of Titel and Wutscherk was used (1972)

$$AKS=\frac{KgMCA*100\ 000}{(talla\ (cm))^3}$$

The reference values of % GC and AKS were those established in the National Institute of Sports Medicine of Cuba by Carvajal (Carvajal and Deturnell, 2016), for each stage of preparation, as a requirement for this sport during the period 2016-2020. These reference values are as follows:

Table 1

Cuban regulations on body composition in high-performance footballers

Sport	General		Special		Competitive	
	%Gr	AKS	%Gr	AKS	%Gr	AKS
Football	9,0	1,19	7,0	1,21	7,0	1,21

Procedure for obtaining information

After obtaining authorization from the institution, information was collected in the archive and laboratory of kineanthropometry at the Provincial Center for Sports Medicine in Villa Clara. The consultation of the kineanthropometric records of each athlete allowed to extract the corresponding data with the first medical check-up performed in each year of the study (2016-2020). For the correct and organized collection of data, a specific model developed for this purpose was used. Five days in the morning were used to take all the information, starting from 2016 and ending in 2020.

Statistical Methods

Descriptive and inferential statistics were used to determine the research objectives. The minimum, maximum, average and standard deviation were determined. Asymmetry, kurtosis was also applied to determine the type of data distribution. To compare the variables between footballers from different game positions and years of study, the ANOVA one-factor hypothesis contrast test was used, considering a 95% confidence interval ($p<0.05$). For statistical analysis, the SPSS version 22.0 package for Windows was used, which allowed to summarize and process the collected data and reflect them in tables and graphs for their proper interpretation.

Ethical considerations

The research was carried out in accordance with the ethical principles set out in the Declaration of Helsinki and subsequent revisions, related to making medical research possible for the benefit of society, as well as the preservation of the legal and ethical rights of the people included in the study. The principles that govern ethics during the process of scientific research have been fulfilled. As the study design is bibliographic, since data from records established for measurements to athletes were used, it was not necessary to request individual informed consent, but assumes responsibility for the results of the study which will be disclosed or applied only with the authorization of the institution and for scientific purposes.

Results and discussion

Table 2 describes the variables of body composition at population level without specifying years or game positions. The result of the data normality test is also shown.

Table 2

Body composition of the footballers studied

Variables	Minimum	Maximum	Stockings	Desv. Standard	Asymmetry	Curtosis

Weight	60,00	98,80	73,23	8,86	0,91	0,51
Size	161,50	196,00	176,54	7,64	0,45	-0,10
%Gr	5,80	22,10	10,71	3,90	1,41	1,51
KgGr	3,70	20,90	7,99	3,75	1,59	2,33
MCA	54,80	84,50	65,31	6,58	0,82	0,20
AKS	0,93	1,47	1,18	0,10	-0,03	-0,18

Note. %Gr= percentage of fat; KgGr= kilograms of fat; MCA = active body mass; AKS= index of active substance.

In relation to the Cuban regulations it was observed that the percentage of fat behaved discreetly above the reference value for the stage, while the index of active substance behaved very similarly. The variables have a normal distribution.

Table 3 describes the percentage of fat and active substance index variables according to game positions and national championships in relation to Cuban regulations.

Table 3

Percentage of fat and index of active substance by positions and championships

Variables	Playing positions				Championships by years				
	PT	DF	MC	DL	2016	2017	2018	2019	2020
%Gr	14,18	11,05	9,02	10,63	10,90	8,54	12,44	11,86	9,52
AKS	1,16	1,19	1,20	1,17	1,17	1,20	1,18	1,20	1,17

Note. PT = portero; DF = defence; MC = midfield; DL = forward; *Percentage of fat good* = 7.31 % - 8.1 %; regular = 8.11 % - 8.9 %; mal = 8.91 % - 9.7 %; very bad > 9.7%; Active substance index good = 1.22 % - 1.16 %; regular = 1.15 % - 1.09 %; mal = 1.08 % - 1.02 %, very bad > 1.02.

Table 3 shows that, in general, the percentage of fat (%Gr) was very poorly evaluated, while the active substance index (AKS) was good. Regarding the playing position, the midfielders had the best %Gr, although rated badly and the goalkeepers the worst (very badly), behaving similarly with respect to the AKS, where the midfielders had a value of 1.20 and the goalkeepers of 1,16 although in this case both positions were evaluated well. Regarding the national championships the best %Gr had the athletes who formed the team that participated in the national championship of 2017 (regular) and the worst was in 2018 (very bad). With respect to AKS the teams that participated in 2017 and 2019 had the best values (good), being the teams of 2016 and 2020 the lowest values with 1.17 although evaluated equally well.

Table 4 describes the variables according to game positions.

Table 4

Body composition according to playing positions

Variables		Stockings	*p.*
Weight	Goalkeeper	82,57**	
	Defence	74,32	
	Midfield	69,70	0,00
	Forward	70,77	
Size	Goalkeeper	183,06**	
	Defence	176,54	0,00

	Midfield	174,56	
	Forward	175,19	
%Gr	Goalkeeper	14,18**	
	Defence	11,05	
	Midfield	9,02	0,00
	Forward	10,63	
KgGr	Goalkeeper	11,86**	
	Defence	8,25	
	Midfield	6,27	0,00
	Forward	7,78	
MCA	Goalkeeper	70,77**	
	Defence	66,04	
	Midfield	63,61	0,00
	Forward	63,02	
AKS	Goalkeeper	1,16	
	Defence	1,19	
	Midfield	1,20	0,63
	Forward	1,17	

Nota. *p. ≤ 0,05; ** 0.01 (bilateral significance)

Table 4 shows that, with the exception of the active substance index (AKS), all other variables show statistically significant differences depending on game positions. It was observed that the goalkeepers presented an average significantly higher than that of the rest of the playing positions, being they who differed from the rest of the positions.

Table 5 describes the variables of body composition at population level according to national championships.

Table 5

Body composition according to national championships

Variables Years		Stockings	p.
Weight	2016	73,07	
	2017	69,91	
	2018	76,50	0,29
	2019	72,91	
	2020	73,46	
Size	2016	177,18	
	2017	174,52	
	2018	178,15	0,44
	2019	174,78	
	2020	177,84	
%Gr	2016	10,90	
	2017	8,54**	
	2018	12,44**	0,01
	2019	11,86	
	2020	9,52	
KgGr	2016	8,01	
	2017	6,04**	0,02
	2018	9,68**	

	2019	8,86	
	2020	7,09	
MCA	2016	65,41	
	2017	63,87	
	2018	66,81	0,55
	2019	64,00	
	2020	66,37	
AKS	2016	1,17	
	2017	1,20	
	2018	1,18	0,84
	2019	1,20	
	2020	1,17	

Nota. *p. ≤ 0,05; ** 0.01 (bilateral significance)

Table 5 shows that there were statistically significant differences in relation to the percentage of fat and kilograms of fat compared to the national championships studied. The players of the team that participated in the 2018 edition showed a significantly higher average in both variables compared to the team of the 2017 edition.

The results of this study showed that the average weight was 73.23 8.86 kg and the size 176.54 7.64 cm, being similar to those obtained by Rojas Valverde et al. (2016), in professional players of first division of Costa Rica (Pino et al., 2019). They also coincide with another study conducted in the Peruvian U22 team (Deidan Saavedra and Moreno Reyes, 2020) and in Ecuadorian footballers (Hernández Mosqueira et al., 2022).

In Cuba there is the antecedent of a research carried out by Pérez Castillo et al. (2020) where they determined the anthropometric characteristics of the footballers that formed the province of Granma, showing similar results. Discreetly higher values were found in a research published by Vieira et al. (2019), where 257 players had an average body mass of 76.7 9.6 kg and a size of 178 0.05 cm.

According to López Cáceres et al. (2019), footballers must have a body fat percentage of 10-11% (2 DE), as obtained in the present study. It is important to mention that, although the regulations of Football in Cuba (Carvajal and Deturnell, 2016) do not recognize this, the data obtained in villaclarenses footballers resemble international results, coinciding with several background findings (Deidan et al., 2020; Pérez Castillo et al., 2020; Pino et al., 2019). On the other hand, Rojas Valverde et al. (2016), obtained a body fat percentage of 15.65 5.14 which exceeds by almost 5% the current finding, while Hernández Mosqueira et al. (2022) obtained an average fat percentage of 21,7 3.3 surpassing the athletes of Villa Clara by more than 10%.

In terms of kilograms of fat (KgGr), active body mass (ACM) and active substance index (AKS) this study is similar to the research conducted by Pérez Castillo et al. (2020) in the

province of Granma, showing parity in body composition between the two provinces. In both cases, according to the regulations of Futbol in Cuba (Carvajal and Deturnell, 2016), the AKS was evaluated well, which speaks for a good musculoskeletal development.

When analyzing the anthropometric characteristics of the players according to their playing position, it was observed that goalkeepers had a higher weight (82.57 kg), height (183.06 cm), percentage of fat (%Gr) (14.18), kilograms of fat (KgGr) (11.86), and active body mass (ABM) (70.77). These differences were significant when compared to the other playing positions (weight p=0.00; height p=0.00; %Gr p=0.00; KgGr p=0.00; ABM p=0.00), which could be associated with the lower energy expenditure due to the less time goalkeepers spend in movement during training and competition (Rodríguez et al., 2019).

An analysis of the physical demands of soccer has shown that goalkeepers have the lowest demands in terms of distance covered and intensity during a match. Players who cover the most ground on the field can travel between 10 and 11 km per game, while goalkeepers cover around 5.6 km per game, almost half the distance of other positions. This could explain the higher prevalence of adipose tissue in goalkeepers (Rodríguez et al., 2019). The higher levels of muscle mass would be explained by the action patterns characteristic of the position, with those related to high force production per unit of time being the most prevalent, and the corresponding impact on muscle architecture (Hernández Mosqueira et al., 2022).

These findings are consistent with those of Díaz Cano et al. (2021) in professional soccer players in Colombia, where goalkeepers were found to have greater body weight, height, percentage of body fat, kilograms of fat, and lean body mass. Similarly, Hernández Mosqueira et al. (2022) found that goalkeepers had greater weight, height, fat mass, and muscle mass, differing significantly from the other positions.

The results obtained are consistent with studies of Uruguayan professional footballers (Fernández et al., 2017), Italian first division footballers (Milanese et al., 2015), UEFA Europa League players (Radzimiński et al., 2020), and footballers who were part of the Granma Social team (Pérez Castillo et al., 2020). In this last study, forwards presented the lowest averages in terms of weight, height, and body fat percentage, differing from our research, where midfielders presented the lowest values.

Deidan Saavedra et al. (2020) and Moran Zuloaga et al. (2022) found that the average weight and height of soccer players studied by playing position are consistent with the evidence obtained, with goalkeepers being the heaviest and tallest. However, regarding

body fat percentage, their studies determined that midfielders had the highest values, which is not the case in the current research, where midfielders presented the lowest body fat percentages. When analyzing the anthropometric characteristics of the players according to national championships, it was observed that the athletes who made up the team that participated in 2018 presented a significantly higher average in terms of body fat percentage (12.44%) and kilograms of fat (9.68) compared to the 2017 team (8.54 and 6.04 respectively), these differences being statistically significant (%BF p=0.01; KgBF p=0.02).

The divergent results may indicate the lack of a single model for the body composition of a soccer team, as this varies depending on several factors. However, it was found that the team that participated in 2016, which won the national championship, had an average body fat percentage of 10.90 and an average body fat percentage of 8.01 kilograms, values that are intermediate between those found in the 2017 and 2018 teams, showing no significant difference from either. Nevertheless, despite having won the championship, it cannot be stated that this is the ideal body composition for elite soccer teams in the province of Villa Clara or in Cuba, since the research did not consider other factors that influence the analyzed variables, nor was each athlete followed up during the national championships.

Conclusions

During the preparatory stage for the National Championship, footballers in the Villa Clara province's social category were characterized by having a body composition similar to that of other national and international teams. Goalkeepers presented significantly higher averages compared to other playing positions in terms of weight, height, body fat percentage, kilograms of fat, and lean body mass. The team that participated in the 2018 National Football Championship showed statistically significant differences compared to the 2017 team in terms of body fat percentage and kilograms of fat.

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