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Anthropometric profile of basketball athletes by game position, competition level and competition ranking: a cross-sectional study

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ORIGINAL ARTICLE

ABSTRACT

Objective: Describe and compare the anthropometric profile of basketball athletes according to their game position, competition level and ranking. Methods: Participants were 189 male basketball athletes competing in the first and second division of the basketball state championship. The anthropometric profile measurements were body mass, height, body fat (skinfold) and somatotype analysis. The athletes were distributed according to their position (guard, forwards and centers), competition level (first and second division) and ranking (semi-finalists) at the competition. Results: The centers presented the highest height and body mass ($p< 0.05$). The first division athletes in all positions were taller ($p< 0.05$) than the athletes from the second division. The best-ranked centers from the first division presented less endomorphic components than the best-ranked centers from the second division ($p< 0.05$). Conclusion: In conclusion, the athletes from higher competition level and better ranked presented higher height and less endomorphic components, which is believed to be important characteristics for performance. Therefore, the anthropometric profiles are likely to play a role in athletic performance.

Keywords: Anthropometry; Body composition; Athletic performance; Athletes.

INTRODUCTION

In basketball, the identification of body composition and the somatotype components are essential factors that predict athletic performance (Alejandro, Santiago, Gerardo, Carlos, & Vicente, 2015). These components are capable to provide indicators of selection and detection of potential athletes (Martín-Matillas et al., 2013) and thus, support coaches to elaborate an optimized training program (Ziv & Lidor 2009). During a training program, the anthropometric profile (e.g. height, weight and somatotype) provides relevant data that support trainers when picking young athletes (Nikolaidis et al., 2014).

The somatotype is characterized by components of endomorphy (relative adiposity) ectomorphy (linearity) and mesomorphy (muscular development), and, together with body mass, height and body fat percentage, compose the anthropometric profile (Carter, Ackland, Kerr, & Stapff, 2005; Martín-Matillas et al., 2013). During a basketball game, the athletes are frequently submitted to more than 2.700 actions of intermittent intensity, which involves running, walking, sprinting and jumping (Scanlan; Dascombe; Reaburn 2011). Recently, studies reported the negative effect of high values of body mass and body fat and, consequently high index of endomorphy, on anaerobic performance (e.g. sprinting and jumping) (Nikolaidis et al., 2014; Ribeiro, Mota, Sampaio-Jorge, Morales, & Leite, 2015). Thus, inappropriate anthropometric profile can limit performance of motor abilities required in a basketball game.

Previous studies with athletes of different team sports indicate that for each position during the game, it is necessary a specifically different body profile (Malousaris et al. 2008; Ramos-Campo et al. 2014). In basketball, the athletes are distributed in three different positions with specific attributions during the game (guards, forwards and centers). According to scientific literature, significant differences in body composition were reported in function of specific

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in-game demands, with centers commonly presenting higher body mass, height and body fat in comparison with forwards and guards (Abdelkrim, Chaouachi, Chamari, Chtara, & Castagna, 2010; Alejandro et al. 2015; Ponce-González, Olmedillas, Calleja-González, & Guerra, 2015). Concerning to somatotype, a review-level evidence observed that players in forwards show predominance in mesomorphy, which suggests that this component, together with lower body mass, can contribute in a situation where the players need higher velocity and agility, as in actions of counter attacks (Ziv & Lidor, 2009). In this sense, it is reasonable to assume that certain parameters of anthropometric profile can aid coaches to define in which position each player should play (Ostojic, Mazic & Dikic, 2006).

In the last decades, many investigation in regard to athletes anthropometric profile proposed to identify morphologic differences between sports modalities (Bayios, Bergeles, & Apostolidis, 2006; Gaurav, Singh, & Singh, 2010), game position (Ostojic et al., 2006; Rivera-Sosa, 2016) and competition level, this last one characterized by team division level (Erčulj, Blas, & Bračič, 2010) and athlete's category (Abdelkrim et al., 2010). In contrast, it is observed a lack in studies which encompasses athlete's anthropometric profiles and final ranking in a tournament. At one of the few studies with this proposal, Carter, Ackland, Kerr, and Stapff (2005) and Martín-Matillas et al. (2013) investigated the morphologic profile of athletes from the women's basketball world championship according to their competition ranking.

From the studies previously mentioned, there is a lack of studies in the anthropometric profile of men's basketball and competition level and ranking. This information has great relevance to support coaches and trainers to advise young athletes according to their body profile, based on descriptive studies that present the relationship of body profile, competition level and ranking, as well as aiding the prescription of the training program. For such, this study proposes to describe and compare the anthropometric profile of basketball athletes in function of their position, competition level and ranking.

METHODS

Participants

The sample was composed of 189 male basketball athletes of 17 teams that compete in the Basketball State Championship of Pernambuco participated in this study. From the 189, 63 athletes were players competing in the first division (FD, age= 21.1 ± 5.46 years) and 126 (age= 28.3 ± 10.1 years) were players competing in the second division (SD). All the participants in this study were competing during a period superior to 3 years and were officially registered in the local Federation of Basketball

Study Design

The present study is descriptive with cross-sectional design. To conduct the data collection, it was performed a survey of the teams and quantity of athletes registered to the Basketball State Federation of Basketball of Pernambuco. It was found 204 athletes, participants of the FD and SD of the Basketball State Championship of Pernambuco. Fifteen participants did not accept to participate in the study or did not attend the inclusion criteria of the study; therefore, our sample comprises 92.6% (189 athletes) of the athletes competing at the Basketball State Championship of Pernambuco. The data collection was performed in two stages, the first moment – the explanation of the study objectives and general procedures – and the second moment – anthropometric evaluations. The data collection was performed in the pre-season, one month before the competition. The procedures were performed in their training center with a previously scheduled visit with athletes and coaches. For study effects, the athletes were distributed according to their position (guards, forwards and centers), competition level, FD versus SD, and by championship ranking, in which were distributed as semi-finalists from FD (SFD) versus semifinalists from the SD (SSD), after the final results. The study was approved by the institutional ethics committee of the center of health sciences from the Federal University of Pernambuco (CAE: 0178.0.172.000-10), following the guidelines of data collection for humans, following the resolution of 466/12 from the Brazilian Health Council of 12/12/2012, as well as rigorously respecting the principles of ethic stated at the Declaration of Helsinki. Each subject signed the informed consent.

Anthropometry

It was assessed the body mass (kg) in an anthropometric scale (Filizola® 110, São Paulo, Brazil) with an accuracy of 0.1kg and height through a stenographer (Sanny®, São Bernardo do Campo, Brazil) with an accuracy of 0.1 cm. For each estimate of somatotype, it was used the same procedures outlined at Carter; Heath (1990), being measured the triceps, suprailiac, subscapular and mid-thigh skinfolds with an adipometer (Cescorf®, Porto Alegre, Brasil), with an accuracy of 0.1 mm. The body circumferences were performed in the biceps brachii, in point of maximal contraction, and the calf, with an anthropometric tape with an accuracy of 0.1 cm. It was assessed the bone diameter of humerus and femur with a pachymeter (Sanny®, São Bernardo do Campo, Brazil) with an accuracy of 0.05 mm. To calculate the corporal density, we used the protocol of Durnin and Womersley (1974), identified by the somatotype of the four skinfolds (biceps, triceps, subscapular and suprailliac). For the estimate of body fat percentage, it was used the equation of Siri (1961). The measures were performed during nighttime and always by the same evaluator. The coefficient of test-retest for each anatomic point exceeded 0.95 and the technical error was inferior to 0.05. All measures followed the standards adopted by the International Society for Advancement in Kinanthropometry (Marfell-Jones, Stewart, & Ridder, 2012).

Statistical Analyses

To verify the data normality, it was used the Shapiro-Wilk test. The data are presented as means and standard deviation. A one-way ANOVA was conducted to compare the dependent variables between position (e.g. guards, forwards and center), competition level (e.g. FD and SD) and ranking (e.g. SFD and SSD). Eta squared partial (partial η^2) was used to determine the effect size. When necessary, it was used a Bonferroni *post hoc* to find significant differences. To assess and compare athletes' somatotype, it was used the calculation of the spatial distance of somatotypes (SDM), proposed by Duquet and Hebbelinck (1977), considering significant values with SDM $\geq$ 1.00. The distance is the result of the square root of the sum of squares of the difference obtained by the following equation: $SDM = \sqrt{(IA - IB)^2 + (IIA - IIB)^2 + (IIIA - IIIB)^2}$, where, DES= spatial distance of somatotypes; I= endomorphy; II= mesomorphy; III= ectomorphy; A e B= indexes of two somatotype to be compared. An analysis of study power *post hoc* was conducted to determine the achieved power, based on the sample size investigated, assuming and alfa error of 0.05, and the effect size achieved. Regarding the position, it was achieved a power > 92.5% for the dependent variables. Regarding the ranking, a power >84.6% was achieved and regarding ranking, a power >80.0% was achieved. All statistical analyses were performed in the Statistical Package for the Social Sciences (SPSS, version 20) for windows (New York, EUA). $p \leq 0,05$ was adopted as statistical significance.

RESULTS

Table 1 presents the descriptions and comparison of athletes' body composition and somatotype in function of their position.

Table 1

Athletes' body composition and components of somatotype per game position

VARIABLES	GUARDS (n=50)	FORWARDS (n=79)	CENTERS (n=60)	Partial η2
Body Mass (kg)	80.3±14.1	84.4±14.4	100.6±15.7[b,c]	0.240
Height (cm)	176.1±7.1[a]	183.0±6.6	193.4±6.9[b,c]	0.484
% Fat	18.0±5.1	17.0±4.7	20.1±5.1[c]	0.07
Endomorphy	3.9±1.5	3.6±1.4	4.5±1.6[c]	0.05
Mesomorphy	4.2±1.3	3.8±1.4	3.6±1.5	0.02
Ectomorphy	1.7±1.2[a]	2.3±1.4	2.1±1.3	0.03

Statistical difference (p<0.05): a= Guards x Forwards; b= Guards x Centers; c= Forwards x Centers.

Table 2

Athletes' body composition and components of somatotype per competition level

VARIABLES	GUARDS		FORWARD		CENTERS	
	FD (n=16)	SD (n=34)	FD (n=24)	SD (n=55)	FD (n=23)	SD (n=37)
Body Mass (kg)	80.6±9.5	80.0±16.1	85.4±11.5	84.0±15.6	101.7±13.3	99.3±17.4
Height (cm)	180.7±6.6*	173.8±6.1	186.2±6.5*	181.6±6.2	197.9±5.1*	190.1±6.1
% Fat	15.6±3.8*	19.2±5.2	16.0±4.4	17.4±4.9	19.6±4.4	20.4±5.3
Endomorphy	3.2±1.1*	4.3±1.7	3.3±1.3	3.8±1.5	3.9±1.4*	4.8±1.7
Mesomorphy	3.8±1.3	4.4±1.2	3.5±1.4	4.0±1.4	3.4±1.22	3.7±1.6
Ectomorphy	2.3±1.1*	1.4±1.2	2.5±1.6	2.2±1.4	2.5±0.9	1.8±1.4

*Statistical difference (p<0.05); FD = First division; SD= Second division.

Table 3

Athletes' body composition and components of somatotype per ranking

VARIABLES	GUARDS		FORWARD		CENTERS	
	SFD (n=12)	SSD (n=12)	SFD (n=14)	SSD (n=16)	SFD (n=18)	SSD (n=18)
Body Mass (kg)	84.0±8.5	78.8±16.2	84.7± 8.6	86.1±11.2	101.0±11.8	105.1±13.6
Height (cm)	183.1±4.3*	175.7±7.5	187.6±5.4*	181.9±5.8	198.2±4.6*	190.6±4.7
% Fat	15.6±3.7	18.8±4.6	13.9±3.5*	17.8±3.3	18.6 ±4.3*	22.1±3.6
Endomorphy	3.2±1.1	4.5±1.6	2.6±0.9*	3.8±1.9	3.6±1.1*	3.8±1.7
Mesomorphy	3.6±1.2	4.7±1.2	3.2±1.5	3.9±1.3	3.1±0.9	2.4±1.6
Ectomorphy	2.3±1.0	1.1±0.9	2.7±1.7	2.3±1.3	2.4±0.8*	2.7±2.0

*Statistical difference (p<0.05); SFD = Semifinalists from first division; SSD= Semifinalists from second division.

The centers presented higher height (F= 87.30; p< 0.001) and body mass (F= 28.78; p> 0.001) than forwards and guards, and higher body fat than forwards (F= 7.03; p= 0.001). The forwards presented higher height than guards (F= 87.30; p< 0.001). For the components of somatotype, it was observed differences in endomorphy between forwards and centers (F= 5.42; p= 0.003), and for ectomorphy between guards and forwards (F= 2.86; p= 0.047). Regarding somatotype classification, the guards and forwards were classified as mesomorph-endomorph and centers were endomorph-mesomorph. When comparing the somatotype between positions, it was not observed statistical differences regarding SDM DES< 1.0.

Table 2 presents a comparison of anthropometric variables between athletes from FD and SD in function of position. The athletes from FD presented higher height in all positions when compared with their pairs, Guards (F= 13.76; p= 0.001), forwards (F= 9.12; p= 0.003) and centers (F= 24.40; p< 0.001); the guards from the FD presented lower body fat than SD (F= 6.13; p= 0.017). Regarding somatotype, guards and centers presented differences in endomorphy (F= 6.29; p= 0.016 and F= 4.35; p= 0.041). The forwards did not present differences. The guards were classified as mesomorph-endomorph for FD and endomorph-mesomorph for SD; the forwards as mesomorph-endomorph for FD and SD and centers as endomorph-mesomorph for FD and SD. Regarding somatotype comparison, it was found differences in guards (SDM= 1.54) and centers (SDM= 1.21) relative to their pairs (PD versus SD).

Table 3 presents the results of the anthropometric profile of athletes of SFD and SSD groups per position. Significant differences were found in height for SFD in comparison to SSD, guards ($F= 5.43$; $p= 0.029$), forwards ($F= 7.65$; $p< 0.001$) and centers ($F= 20.39$; $p< 0.001$). Forwards and centers SSD presented higher body fat in comparison to SFD ($F= 9.69$; $p= 0.004$ and $F= 7.41$; $p= 0.010$). For the components of somatotype, it was not observed differences in guards; forwards presented differences for endomorphy ($F= 11.29$; $p= 0.002$); and the centers for endomorphy ($F= 17.80$; $p< 0.001$). Regarding somatotype classification, guards were classified as endomorph-mesomorph for SFD and SSD. The forwards were classified as mesomorph for SFD and endomorph-mesomorph for SSD. The centers were classified as endomorph-mesomorph for SFD and endomorph for SSD. Regarding somatotype, it was found differences in forwards (SDM= 1.81) and centers (SDM= 2.04) relative to their pairs (SPD versus SSD).

DISCUSSION

The main finding of the present study was to characterize distinct anthropometric profiles of players that assumed different position (guards, forwards and centers) in basketball, competition level (FD and SD) and ranking (SFD and SSD). It was observed differences in body composition and somatotype, especially for height. These findings corroborate with previous studies that reported differences in body profile among athletes of different sports modalities, including basketball (Abdelkrim et al., 2010; Nikolaidis & Ingebriggtsen, 2013; Ramos-Campo et al., 2014; Alejandro et al., 2015).

Regarding the comparison relative to the game position, our findings are similar to other studies presented in the literature, in which is possible to infer that the specific position demand requires a different anthropometric profile, due to the execution of motor actions inherent to that position (Malousaris et al., 2008). A review study conducted by Ziv and Lidor (2009) investigated the anthropometric profile of men's and women's basketball athletes and found that differences in body mass and height are the most frequently reported, especially with regard to gaming attributions. In this sense, investigations conducted by Boone and Bourgois (2013) and Ponce-González, Olmedillas, Calleja-González and Guerra (2015) in elite basketball players corroborated with our findings, confirming that centers display higher height than guards and forwards, as well as higher body mass than guards. From this, it is possible to suggest that these differences in body composition in centers highlight the importance of physical attributes, favoring them in space dispute, mainly on rebound actions and pitches close to the hoop (Ostojic et al., 2006; Ziv & Lidor, 2009).

Concerning height, it was verified that according to the competition level and ranking in the championship, the athletes, both FD and SD displayed higher height when compared to SD and SSD. Erčulj, Blas, and Bračič, (2010) found that the A division of women's category from the European Basketball Championship presented higher height than athletes from B division and C. Carter et al., (2005) compared four out of five best positioned teams with four out of five worst positioned teams from the Women's World Championship of 1994 and found that the best-positioned guards and centers were seven and six centimeters taller, respectively. It was expected that the athletes with higher competition level and ranking presented increased height due to the higher demands required, also because this characteristic is associated with other factors, as higher performance, technical performance and tactics. Apparently, height demonstrated to be a parameter that may be used to select and guide coaches to choose the athletes' specific functions and position in basketball (Ostojic et al., 2006).

Regarding the somatotype analyses, the SDM did not show differences between player's position, although it was found differences in individual components. The centers presented higher endomorphy components than forwards, while ectomorphy was more prevalent in forwards than guards but no differences in mesomorphy. The similar mesomorphic components suggest that muscle mass may be an important factor for basketball, independent of position, which can contribute in disputes that involve physical contact during the game (Bayios et al., 2006; Martinez, Lopez, Meza, Millan, & Leon, 2014). A study conducted by Carter et al., (2005) also found differences in somatotype components when assessed the players from the women's basketball World Championship. Regarding the somatotype analyses concerning competition level and ranking, the SDM was different in guards and centers athletes from the FD when compared to SD, as well as forwards and centers from SFD to SSD. In an individual analysis of somatotype components, it was found that endomorphy was responsible for these changes, where SD athletes displayed higher endomorphic components than FD. It is important to highlight that endomorphic components were observed along with the percentage of body fat. According to Wilmore and Costill (1999), the ideal percentage of body fat for basketball athletes should fluctuate between 6 to 15%, but these values were not observed in our study. This data suggests that high endomorphy and percentage of body fat may be associated with reduced athletic performance, mainly in intermittent tasks, which was reported about 1050 movements in a basketball game and that corresponds to movement changes every 2 seconds (Abdelkrim, Fazaa, & Ati 2007). Reinforcing this concept, the study of Martín-Matillas et al., (2013) found a negative relationship between endomorphy and percentage of body fat with athletic performance. In this sense, it is likely that there is a negative influence of endomorphy and body fat on performance variables, and thus, emphasize the influence of assessing these parameters in basketball athletes.

Therefore, the results presented here suggest that according to the game demands and functions, a specific anthropometric profile is needed, and these patterns can aid the process of detection and selection of players for each position. Although the success in sports is the result of the interaction of many aspects, such as technical, tactical and motor, it is likely that the combination of increased height with less percentage of body fat and endomorphy can favor athletic performance. Although our findings can aid coaches and physical trainers to choose and prepare athletes accordingly with their physical profile, this study has some limitation inherent to its cross-sectional design. In this sense, we recommended next studies to conduct a follow-up design with athlete's body profile and track their performance throughout the competition. Also, it may be interesting to use methods with increased reliability in order to avoid measurement errors.

CONCLUSION

It is possible to infer that the anthropometric profile is an important component of the athletic performance, and the athletes with higher competition level and better classified in the championship presented increased height and less endomorphy, this in turn, can be an important physical attribute to succeed in basketball. Therefore, our data can favor coaches during the process of selection and orientation of young athletes of basketball, from the point of view of the anthropometric profile, a critical attribute to achieve success in basketball.

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