ORIGINAL ARTICLE

The Effect of Anthropometric Characteristics and Somatotypes of Basketball Players on their Basketball Skills

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ABSTRACT
Aim: The aim of this study was to determine how the somatotypes and anthropometric characteristics of basketball players affect their basic basketball skills.
Methods: For this purpose, a total of 290 male athletes between 12-16 years and from Kahramanmaraş and nearby provinces (Adana, Osmaniye, Gaziantep, Şanlıurfa, Adıyaman) who play basketball [(mean±SD) age: 13.7 ± 1.2 years; height: 173.4 ± 11.1 cm; body weight: 63.9 ± 14.6 kg; years played: 2.7 ± 1.5 years] participated in the study as volunteers. Participants and their parents completed and signed the informed consent forms. The approval of Kahramanmaraş Sütçü İmam University, Faculty of Medicine, Scientific Research Ethics Committee was obtained for the study. All participants were assessed for length, circumference, diameter, and skinfold thickness, as well as their somatotype number. The basketball skills were tested using AAPHER Basketball Skills Test. In this method, speed shooting, passing, dribbling, and defense skill tests were applied. Statistical analysis of the collected data was performed using SPSS Statistics Software Package. Descriptive statistical methods (arithmetic mean, standard deviation) were used to analyze the study data. To determine the relationship between quantitative data, Kolmogorov-Smirnov and Shapiro-Wilk normality tests were performed at a significance level of $P<0.05$ in order to first understand whether the measurement values were normally distributed. Since the data were not normally distributed, Spearman's correlation test was used to determine whether there was a significant correlation between the variables.
Conclusions: In conclusion, it can be said that anthropometric, somatotype and physical characteristics of basketball players between 12-16 years positively affect their basketball skills. That is, we can conclude that the skills of basketball players improve as their physical characteristics improve, their basketball skills improve as their anthropometric characteristics improve.
Keywords: Basketball skills, anthropometric characteristics, somatotype.

INTRODUCTION
Within the competition characteristics of basketball, physical structure, physiological capacity, psycho-mental status, bio-motor characteristics (speed, endurance, mobility-flexibility, coordination), technical structure, tactical understanding, team discipline, and coach/sports scientist are of the essence (Kılınç, 2008; Drinkwater, Pyne and Mckenna, 2008;Carter et al., 2005). Although there are many models for technical assessment, in general, American Alliance for Health, Physical Education, Recreation and Dance can be given as one of the examples of the technical tests used (AAHPERD, 1984). In our country, technical assessment is mostly done visually, there is a limited number of studies, and practically the technical assessment of basketball players under field circumstances can only be done partially (Knudson, 1993). Anthropometric and physiological assessments were performed to contribute to the selection of the athlete and the training models to be implemented, and the generation of foresight regarding the targeted success (Albay et al., 2008). Studies performed on athletes revealed that different populations and different branches of sports have different body composition and somatotype characteristics. Therefore, many researchers worked on different populations and branches of sports, developed body composition ratios specific to a certain branch of sports, and made use of these ratios in their studies (Carter et al., 1990; Heyward and Stolarczyk, 1996). Determining the anthropometric and physiological characteristics may contribute to the selection of criteria required to achieve success for younger basketball players (Hoare, 2000).

From an athletic point of view, anthropometric measurements are required in order to identify the branches of sports the individuals will be guided toward, determine the effects of training on morphological structure, and monitor the performance status of the athletes. It was stated that knowing somatotype and body composition characteristics may be useful for the organization of training programs to determine the athlete's skills, increase and develop the athletic performance and technical skills (Gualdi-Russo and Zaccagni, 2001). The aim of the current study was to determine how the somatotype and anthropometric characteristics of basketball players affected their basic basketball skills.

MATERIALS AND METHODS
Study Group: This study was based on an experimental model that will demonstrate the type of relationship between the anthropometric characteristics and somatotypes of basketball players aged 12-16, and their basketball skills. A total of 290 male athletes between 12-16 years who play basketball [(mean ± SD) age: 13.7 ± 1.2 years; height: 173.4 ± 11.1 cm; body weight: 63.9 ± 14.6 kg; years played: 2.7 ± 1.5 years] participated in the study as volunteers.
Study Design: The study sample consisted of basketball players aged 12-16 years in Kahramanmaraş and nearby provinces (Adana, Osmaniye, Gaziantep, Şanlıurfa, Adıyaman). The participants and their parents were fully

informed about the study design, risks and benefits before signing an informed consent form. Athletes were free to withdraw from the study anytime during the study period. The research was performed in accordance with the ethical standards for research involving human subjects stated in the Declaration of Helsinki. This study was performed with the approval (11.08.2014, meeting no. 2014/10, protocol no. 126, approval no. 11) obtained from Kahramanmaraş Sütçü Imam University, Faculty of Medicine, Scientific Research Ethics Committee.

Assessment of Anthropometric Characteristics: Measurements of skinfold thickness were made using Holtain brand skinfold caliper (triceps, scapular, suprailiac, calf), and length (arm span, leg length, knee length, arm length, upper arm length, lower arm length, hand length, hand width, foot length, and foot width), circumference (wrist circumference, biceps circumference, thigh circumference, calf circumference) and diameter measurements (humerus bicondylar diameter, femur bicondylar diameter) were made using Lafayette anthropometric measurement set. Somatotype Assessment was performed using Heath-Carter Somatotype Method to determine the somatotype numbers of the subjects. According to this method, body weight, height, biceps and calf circumferences in flexion, humerus and femur diameters, and triceps, subscapular, suprailiac, and thigh skinfold thicknesses were used to calculate the somatotype numbers using the following formulas (Heath and Carter, 1967).

Endomorphy= 0.7182 + 0.1451* (X) * 0.00068 * (X^2) + 0.0000014 *(X^3)

X value (X = triceps sft +suprailiac sft + subscapular sft: sum of three skinfold thicknesses) before using in endomorphy calculation, height correction was made and corrected X value was used.

Height Correction Formula: Corrected Total Skinfold Value = X * 170.18 / height (cm).

Mesomorphy = [0.858 * humerus bicondylar diameter (cm) + 0.601 * femur bicondylar diameter (cm) + 0.188 * corrected arm circumference (cm) + 0.161 * corrected calf circumference (cm)] – [0.131 * body height (m)] + 4.50

Corrected Arm Circumference = Arm Circumference – Triceps SFT /10

Corrected Calf Circumference = Calf Circumference – Calf SFT /10.

Ectomorphy= Height (m) – weight ratio (kg) =

If Height (m)/ $\sqrt[3]{\text{Weight}}$, Height-weight ratio>40.75;

Ectomorphy = 0.732 * Height-weight ratio – 28.58

If 40.75 >Height-weight ratio>38.25;

Ectomorphy = 0.463 * Height-weight ratio -17.615

If Height-weight ratio <38.25;

Ectomorphy = 0.1 (or 1/2).

To test basketball skills, researchers who perform technical analysis in this field mostly use the American Alliance for Health, Physical Education, Recreation and Dance (AAPHERD) for the technical assessment of 10-18-year-olds. Our analysis included shooting, passing, dribbling, defensive slide (AAHPERD, 1984; Kılınç, Erol and Kumartaşlı, 2011; Strand and Wison, 1993) and was performed using AAPHER Basketball Skills Test. In this method, volunteering basketball players were tested for their speed shooting, passing, dribbling, and defensive skills. Each test had its own scoring system.

Statistical Analysis: When analyzing the data obtained from the study, the SPSS statistics software package was used to perform statistical analyses. When evaluating the study data, methods of descriptive statistics (Mean, Standard deviation) were used. To determine the relationship between quantitative data, Kolmogorov-Smirnov and Shapiro-Wilk normality tests were performed at a significance level of P<0.05 in order to first understand whether the measurement values were normally distributed. Since the data were not normally distributed, Spearman's correlation test was used to determine whether there was a significant correlation between the variables.

RESULTS

Table 1. The AAPHER Basketball Skills Test scores of the basketball players participating in the study

	Min	Max	X ± SS
Speed spot shooting	21,0	46,0	32,1 ± 5,9
Passing	47,0	92,0	71,8 ± 9,5
Control Dribbling Left Hand (sec)	18,2	33,2	22,5 ± 3,4
Control Dribbling Right hand (sec)	17,5	32,5	21,7 ± 3,3
Defensive Movement (sec)	19,3	34,6	25,8 ± 3,9

Table 2. Length and diameter values of the basketball players participating in the study

	Min	Max	X ± SS
Arm Span (cm)	153,0	199,0	174,2 ± 12,1
Leg Height (cm)	90,0	120,0	104,0 ± 8,4
Knee Height (cm)	43,0	58,0	50,2 ± 4,3
Arm lenght (cm)	65,00	86,0	74,2 ± 5,9
Upper arm length (cm)	32,0	46,0	37,8 ± 3,5
Lower arm length (cm)	24,5	33,0	29,1 ± 2,2
Hand length (cm)	17,0	22,0	19,8 ± 1,5
Hand Width (cm)	7,5	12,0	9,6 ± 1,1
Foot Length (cm)	24,0	30,5	27,1 ± 2,0
Foot Width (cm)	10,0	15,0	11,8 ± 1,2

Table 3. Diameter, circumference, skinfold thickness and somatotype values of basketball players participating in the study

	Min	Max	X ± SS
Wrist Circumference (cm)	15,0	20,0	17,1 ± 1,2
Arm Circumference (cm)	20,0	34,0	27,7 ± 2,7
Thigh circumference (cm)	42,0	64,0	53,7 ± 5,4
Calf Circumference (cm)	28,0	42,0	36,0 ± 3,3
Triceps Skinfold thickness (mm)	5,8	30,0	14,9 ± 5,6
Iliac skinfold thickness (mm)	4,5	35,0	13,9 ± 7,2
Calf Skinfold thickness (mm)	3,0	20,0	8,6 ± 3,6
Scapula skinfold thickness (mm)	6,0	25,0	11,4 ± 4,8
Femur bicondylar diameter (cm)	7,6	10,7	9,2 ± 0,8
Humerus bicondylar diameter (cm)	5,1	7,2	6,2 ±0 ,5
Endomorph	1,5	7,7	4,0 ± 1,5
Mesomorph	,6	5,4	3,3 ± 1,4
Ectomorph	1,0	6,1	3,4 ± 1,3
BMI(kg/m^2)	15,6	27,6	21,1 ± 2,8

Table 4. Correlation between the physical characteristics and the AAPHER Basketball Skills Test scores of the basketball players participating in the study

			Speed spot shooting	Passing	Control Dribbling (sec)		Defensive Movement (sn)
					Left	Right	
Spearman's rho	Age (Year)	r	,303**	,328**	-,744**	-,598**	-,745**
		p	,000	,000	,000	,000	,000
	Height (cm)	r	,227**	,391**	-,523**	-,438**	-,468**
		p	,000	,000	,000	,000	,000
	Body weight (kg)	r	,022	,201**	-,443**	-,407**	-,402**
		p	,737	,001	,000	,000	,000
	Sports age (year)	r	,335**	,283**	-,345**	-,322**	-,404**
		p	,000	,000	,000	,000	,000

*p<0.05, **p<0.01

Regarding the physical characteristics and the AAPHER Basketball Skills Test scores of the basketball players participating in the study, a significant (p=0.01, p<0.01) positive weak correlation was detected between the ages and speed shooting skills and passing skills of the basketball players whereas a significant (p<0.01) strong negative correlation was detected between the ages and dribbling and defensive skills of the basketball players. That is, it can be said that with increasing age, the basketball players have better speed shooting, passing, dribbling, and defensive skills. A significant (p<0.01) positive weak correlation was found between the heights and speed shooting and passing skills of the basketball players whereas there was a significant (p<0.01) moderate negative correlation between their heights and dribbling and defensive skills. Based on this finding, it can be said that with increasing height, the basketball players have better shooting, passing, dribbling, and defensive skills. While there was no significant correlation (p>0.05) between the body weights and speed shooting skills of the basketball players, we found a significant (p<0.01) positive weak correlation between the body weight and passing skills, and a significant (p<0.01) negative moderate correlation between body weight and dribbling and defensive skills. It can be said that increased body weight did not have a significant effect on speed shooting skills but improved dribbling and defensive skills. We found a significant positive moderate correlation between the years played and speed shooting skills and passing skills, whereas we found a significant positive moderate correlation between the years played and dribbling and defensive skills. We can say that basketball skills improve with the increasing number of years played.

Table 5. Correlation between the length and width values and the AAPHER Basketball Skills Test scores of the basketball players participating in the study

			Speed spot shooting	Passing	Control Dribbling (sec)		Defensive Movement (sec)
					Left	Right	
Spearman's rho	Arm Span (cm)	r	,245**	,386**	-,549**	-,495**	-,504**
		p	,000	,000	,000	,000	,000
	Leg Height(cm)	r	,272**	,433**	-,364**	-,287**	-,496**
		p	,000	,000	,000	,000	,000
	Knee Height (cm)	r	,121	,345**	-,529**	-,496**	-,415**
		p	,061	,000	,000	,000	,000
	Arm lenght (cm)	r	,224**	,492**	-,503**	-,431**	-,566**
		p	,000	,000	,000	,000	,000
	Upper arm length (cm)	r	,287**	,540**	-,572**	-,609**	-,405**
		p	,000	,000	,000	,000	,000
	Lower arm length (cm)	r	,142*	,368**	-,581**	-,567**	-,461**
		p	,028	,000	,000	,000	,000
	Hand length (cm)	r	,226**	,446**	-,502**	-,447**	-,529**
		p	,000	,000	,000	,000	,000
	Hand Width (cm)	r	,177**	,224**	-,595**	-,705**	-,452**
		p	,006	,000	,000	,000	,000
	Foot Length (cm)	r	,152*	,399**	-,472**	-,466**	-,409**
		p	,019	,000	,000	,000	,000
	Foot Width (cm)	r	,039	-,047	-,349**	-,380**	-,175**
		p	,552	,461	,000	,000	,008

*p<0.05, **p<0.01

Regarding the correlation between the length and width values of the basketball players participating in the study and their AAPHER Basketball Skills Test scores, a significant (p<0.01) positive weak correlation was found between the arm span and speed shooting and passing skills, whereas a significant (p<0.01) negative moderate correlation was found between the arm span and dribbling and defensive skills. Leg height had a significant (p<0.01) positive weak correlation with speed shooting skills, a significant (p<0.01) negative weak correlation with dribbling skills, a significant positive moderate correlation with passing skills, and a significant negative moderate correlation with defensive skills. While the correlation between knee height and speed shooting skills was not significant (p>0.05), there was a significant (p<0.01) positive moderate correlation between knee height and passing skills, and a significant (p<0.01) negative moderate correlation between knee height and dribbling and defensive skills. Arm length had a significant (p<0.01) positive weak correlation with speed shooting skills, a significant (p<0.01) positive moderate correlation with passing skills, and a significant (p<0.01) negative moderate correlation with dribbling and defensive skills. Upper arm length had a significant (p<0.01) positive weak correlation with speed shooting skills, a significant (p<0.01) positive moderate correlation with passing skills, and a significant (p<0.01) negative moderate correlation with dribbling and defensive skills. Lower arm length had a significant (p<0.05) positive weak correlation with speed shooting skills, significant (p<0.01) positive moderate correlation with passing skills, and a significant (p<0.01) negative moderate correlation with dribbling and defensive skills. Hand length had a significant (p<0.01) positive weak correlation with speed shooting skills, a significant (p<0.01) positive moderate correlation with passing skills, and a significant (p<0.01) negative moderate correlation with dribbling and defensive skills. Hand width had a significant (p<0.01) positive weak correlation with speed shooting and passing skills, and a significant (p<0.01) negative moderate correlation with dribbling and defensive skills. Foot length had a significant (p<0.05) positive weak correlation with speed shooting skills, a significant (p<0.01) positive moderate correlation with passing skills, and a significant (p<0.01) negative moderate correlation with dribbling and defensive skills. The correlation between foot width and speed shooting and passing skills was not significant (p>0.05), but the correlation between foot width and dribbling and defensive skills was significant (p<0.01), negative and weak. It can be said that basketball skills improve as the length and width values increase.

Table 6. Correlation between the diameter, circumference, and skinfold thickness measurements and the AAPHER Basketball Skills Test scores of the basketball players participating in the study

			Speed spot shooting	Passing	Control Dribbling (sec)		Defensive Movement (sec)
					Left	Right	
Spearman's rho	Wrist Circumference (cm)	r	,063	,124	-,374**	-,403**	-,506**
		p	,329	,051	,000	,000	,000
	Arm Circumference (cm)	r	-,096	-,217**	-,221**	-,309**	-,044
		p	,138	,001	,001	,000	,506
	Thigh circumference (cm)	r	,005	,064	-,265**	-,236**	-,182**
		p	,941	,313	,000	,000	,006
	Thigh circumference (cm)	r	-,151*	-,034	-,248**	-,283**	-,247**
		p	,020	,588	,000	,000	,000
	Triceps skinfold thickness (mm)	r	-,150*	-,164**	,212**	,063	,250**
		p	,020	,010	,001	,343	,000
	Iliac skinfold thickness (mm)	r	-,196**	-,234**	-,034	-,107	,145*
		p	,002	,000	,607	,104	,028
	Calf skinfold thickness (mm)	r	-,209**	-,197**	,010	-,057	,136*
		p	,001	,002	,875	,388	,039
	Scapula skinfold thickness (mm)	r	-,146*	-,180**	-,146*	-,186**	,049
		p	,024	,004	,026	,005	,463
	Femur bicondylar diameter (mm)	r	,185**	,112	-,307**	-,355**	-,208**
		p	,004	,077	,000	,000	,001
	Humerus bicondylar diameter (mm)	r	,212**	,179**	-,626**	-,579**	-,590**
		p	,001	,004	,000	,000	,000

*p<0.05, **p<0.01

Regarding the correlation between diameter, circumference, and skinfold thickness values of the basketball players participating in the study and their AAPHER Basketball Skills Test scores, there was no significant (p>0.05) correlation between wrist circumference and speed shooting and passing skills, arm circumference and speed shooting and defensive skills, thigh circumference and speed shooting and passing skills, calf circumference and passing skills, triceps skinfold thickness and dribbling skills (right hand), iliac skinfold thickness and dribbling skills (right and left hand), calf skinfold thickness and dribbling skills (right and left hand), scapula skinfold thickness and defensive skills, and femur bicondylar diameter and passing skills. There was a significant (p<0.01) negative weak correlation between wrist circumference and dribbling skills and a significant (p<0.01) negative moderate correlation between wrist circumference and defensive skills, a significant (p<0.01) negative weak correlation between arm circumference and passing skills and dribbling skills, a significant (p<0.01) negative weak correlation between thigh circumference and dribbling and defensive skills, a significant (p<0.05) negative weak correlation between calf circumference and speed shooting skills and a significant (p<0.01) negative weak correlation between calf circumference and dribbling and defensive skills. Triceps skinfold thickness had a significant negative weak correlation with speed shooting skills (p<0.05) and passing and defensive skills (p<0.01), and a significant (p<0.01) positive weak correlation with dribbling skills. Iliac skinfold thickness had a significant negative correlation with speed shooting skills and passing skills (p<0.01) and defensive skills (p<0.05). A significant negative weak correlation was detected between calf skinfold thickness and speed shooting skills and passing skills (p<0.01) and defensive skills (p<0.05). A significant negative weak correlation was detected between scapula skinfold thickness and speed shooting skills (p<0.05), passing skills (p<0.01), and left hand (p<0.05) and right hand (p<0.01) dribbling skills. Femur bicondylar diameter had a significant positive weak correlation with speed shooting skills (p<0.01), a significant negative weak correlation with dribbling and defensive skills (p<0.01). Humerus bicondylar diameter had a significant positive weak correlation with speed shooting and passing skills (p<0.01), and a significant negative moderate correlation with dribbling and defensive skills (p<0.01).

Table 7. Correlation between the somatotype numbers and the AAPHER Basketball Skills Test scores of the basketball players participating in the study

			Speed spot shooting	Passing	Control Dribbling (sec)		Defensive Movement (sec)
					Left	Right	
Spearman's rho	BMI (kg/m²)	r	-,181**	-,211**	-,367**	-,378**	-,288**
		p	,005	,001	,000	,000	,000
	Endomorphy	r	-,193**	-,262**	,111	-,007	,258**
		p	,003	,000	,094	,917	,000
	Mesomorphy	r	-,053	-,381**	-,061	-,221**	,104
		p	,410	,000	,354	,001	,115
	Ectomorphy	r	,187**	,481**	,151*	,246**	-,050
		p	,004	,000	,022	,000	,449

*p<0.05, **p<0.01

Regarding the somatotype numbers and the AAPHER Basketball Skills Test scores of the basketball players participating in the study, a significant (p<0.01) negative weak correlation was found between the BMI and basketball skills test scores. Endomorphy had a significant negative weak correlation with speed shooting and passing skills, a significant (p<0.01) positive weak correlation with defensive skills, and no correlation with dribbling skills. Mesomorphy had a significant (p<0.01) negative weak correlation with passing and dribbling skills, and no significant (p>0.05) correlation with speed shooting skills and left-hand dribbling. Ectomorphy had a significant (p<0.01) positive weak correlation with speed shooting and dribbling skills, and a significant (p<0.05) positive moderate correlation with passing skills, and no significant (p>0.05) correlation with defensive skills.

DISCUSSION

When the correlation between physical characteristics and the AAPHER Basketball Skills Test scores of the basketball players participating in our study is analyzed, it can be said that the speed shooting skills, passing skills, dribbling skills, and defensive skills improve as the athlete's age increases. In the literature, it is acknowledged that age is proportional to the psychological and physiological development of the individual. Therefore, until adolescence, competitions are organized according to the age group. This is attributed to the observation that individuals with the birth date prior to others within the same team have better technique and skills. This is referred to as the relative age effect and indicates that the differences between individuals in a certain age group are not only associated with skills and abilities but also the level of development of the body (Ibáñez et al., 2018; Sürücü et al., 2018). In young teams, players are characterized by a similar chronological age but different developmental status and anthropometric features, and understanding these variables is considered the main factor in performance (Clemente et al., 2019).

Data obtained through our study are of great importance as they indicate that basketball players have better speed shooting, passing, dribbling, and defensive skills as their height increases, as well as helping to determine the positions of the players within the team. Since the players have to do the drills as fast as possible, these tests rely on speed and anaerobic conditions (Bogdanis et al., 2007). However, being tall is also considered an advantage (Drinkwater, Pyne and Mckenna, 2008; Kılınç, Erol and Kumartaşlı, 2011). Moreover, studies that changed the preconceived idea that “tall players cannot dribble” in the basketball communities in Turkey demonstrated that being tall and athletic contributed significantly to the athletic ability of the basketball players (Daniel, Amador, and José, 2012). In a study, a significant inverse correlation was found between height and weight and turnover frequency in the age group under 14 (Clemente et al., 2019).

In our study, we found that the bodyweight of the basketball players did not affect their speed shooting skills. This can be explained by the fact that field goal percentage is affected by the shooting style and technique of the athlete. Moreover, in our study, we found that bodyweight contributed less to passing skills, but had a negative effect on dribbling and defensive skills. The phenomena of athletics and speed, which are the essence of basketball, indicate that basketball players must be athletic, an inference that is also corroborated by our measurements. However, the findings in the literature indicate that the body weights of players change depending on their field positions and those players with the highest bodyweight play pivot while those with the lowest body weight play guard (Ramos et al., 2019; Ostojic, Mazic and Dikic, 2006). In basketball, greater height and body dimensions contribute to better performance. For example, basketball players are taller than the players of other sports such as volleyball and handball, and their limbs are longer. In addition, players with better speed, strength, and agility skills are advantageous in the game (Garcia-Gil et al., 2018).

It was found that the speed shooting, passing, dribbling, and defensive skills of the athletes participating in our study were positively affected as the age of the athlete increased. We observed that, as the years played increased, efficient use of this time positively affected physical, anthropometric, and physiological suitability parameters (Yörükoğlu and Mitat, 2007). A perfect basketball player can feel the fine changes in the ball, and in this way, during the game, can pass the ball to the right person at the right time, can dribble and shoot. Therefore, a good sense of the ball is very important to win the game (Su and Yang, 2018).

Considering the length and width values of the basketball players participating in the study and the values of the AAPHER Basketball Skills Test, we observed that the arm span of the basketball players contributed positively to their speed shooting and passing skills, but we came to the conclusion that as the arm span increased, dribbling skills and defensive skills were negatively affected. We can say that the reason for this is the problems experienced by the athletes with long arm span in ballhandling. Dribbling, passing and shooting skills, which are known as the fundamental (basic) skills of basketball, are the skills that every player should learn and practice in the best way (Savucu et al., 2004; Ulusu, Keser and Gündüz, 2018). If the number of fundamental exercises in basketball can be increased in training for athletes who are taller and with a smaller number of years played, this may be resolved and the ballhandling in positions where tall basketball players have to dribble can be improved. This indicates that the negative effect of leg height on dribbling skills in our study is a problem that arose due to a similar reason. In addition, in our study, it was found that leg height contributed a little to the speed shooting ability. We can say that this situation is related to the shooting style of the athlete. Considering the effect of leg height on the passing skills, a more positive result was obtained, and in similar studies, it was stated that players had a moderate positive relationship between leg height and hand length, they could jump a greater distance horizontally and throw the ball (Savucu et al., 2004). However, it was found that the contribution of leg height to defensive skills was negative. As the parameters such as knee height, arm length, upper arm length, lower arm length, hand length, hand width, foot length, foot width increase, they contributed positively to passing skills, speed shooting skills and defensive skills scores, but not to the dribbling skills, and we can say that the basketball skills of the athletes who participated in our study increased. According to the studies on anthropometric measurements performed in similar age groups, when individuals with long and wide limbs are developed with training, it is possible to make a critical contribution in terms of increased ball grip strength, and faster movement in a balanced manner (Kinnunen et al., 2001).

Regarding the relationship between the diameter, circumference and skinfold thickness values of the basketball players participating in the study and the values of the AAPHER Basketball Skills Test, no significant correlation ($p>0.05$) was found between the wrist circumference and the speed shooting and passing skills; between calf circumference and passing skills, between triceps skinfold thickness and dribbling skills (right hand), between iliac skinfold thickness and dribbling skills (right and left hand), calf skinfold thickness and dribbling skills (right and left hand), between scapula skinfold thickness and defensive skills, femur bicondylar diameter and passing skills. In addition, it was observed that as the wrist circumference of the athletes who participated in our study increased, their dribbling and defensive skills were weakened; passing and dribbling skills were negatively affected as the arm circumferences increased; as the thigh circumference increased, dribbling and defensive skills decreased; as the calf circumference increased, speed shooting, dribbling and defensive skills were negatively affected. It was found that as the thickness of the triceps skinfold increased, speed shooting, passing and defensive skills were negatively affected, but dribbling skills improved slightly. had a small positive effect on dribbling ability.

Regarding the relationship between the iliac, calf and scapula skinfold thicknesses and speed shooting, passing and defensive skills of the athletes participating in our study, it was found that as the thickness of the iliac skinfold increased, the basketball players' speed shooting, passing and defensive skills were negatively affected. Likewise, as the thickness of the calf skinfold increased, basketball players' speed shooting, passing and defensive skills were negatively affected; as the thickness of the scapula skinfold increased, speed shooting, passing and dribbling (right and left hand) skills were negatively affected.

Regarding the effects of the diameter measurements obtained from the athletes on basketball skills, although the increase in the femur bicondylar diameter had a small positive effect on the speed shooting skills, it was found that it had a negative effect on the dribbling skills and the defensive skills. In addition, increased humerus bicondylar diameter only positively slightly increased the speed shooting and passing skills of the athletes whereas it had a negative effect on their dribbling and defensive skills.

Considering the relationship between the somatotype numbers of the basketball players participating in the study and the AAPHER Basketball Skills Test scores, it can be seen that the basketball skills of the athletes were negatively affected as the BMI increased. Moreover, it was found that;

- Athletes with endomorph somatotype were inadequate in terms of speed shooting and passing skills and less adequate in terms of defensive skills, but their somatotypes did not have any effect on their dribbling skills.
- Athletes with mesomorph somatotype had poor passing and dribbling (right hand) skills, but their somatotypes did not have any effect on their speed shooting and ballhandling skills.
- Athletes with ectomorph somatotypes had better speed shooting, passing and dribbling skills, but their body type did not have any effect on their defensive skills.

In fact, the anthropometric characteristics of an athlete are an important predictor of whether the athlete will reach the top level in the sport he chooses. Players with greater height, body mass, body mass index, arm span, biceps circumference when contracted, and with a total of 8 skinfolds performed worse in dribbling tests. Height, body mass, and contracted biceps circumference were positively associated with all of the performance variables except the number of assists and, in the case of the arm span, also the number of points (Garcia-Gil et al., 2018).

Individual and team success in basketball is closely related to anthropometric and fitness features. For example, anthropometric and fitness tests explain 40% of the variance in game performance. In fact, the findings that body dimensions and fitness are key determinants of performance in basketball are intuitive for basketball coaches. Similarly, another study found that top players were taller, had more lean mass, more strength, power, and agility, and they were technically more skilled compared to lower-level players according to the tests that monitor training experience and maturity. The results of the dribbling and defensive movement tests also depend on anaerobic capacity. The dribbling and defensive movement indices of young basketball players aged 7-17 are in accordance with good or excellent technical conditions. In addition, shooting skills showed the greatest variation in the 9, 12-13, and 15 age groups. The findings in the literature state that the best periods to develop technical skills including dribbling and shooting are between the ages of 7-10 and 12-13, and defensive movements can be developed at the age of 14-15 (Matulaitis et al., 2019).

CONCLUSION

Based on our results, in a branch of sports that demands high performance, like basketball, for the athletes to reach higher levels, their bio-motor characteristics, physical structure and physiological capacity level, technical and tactical knowledge, as well as their anthropometric characteristics must be top level. The way to bring these requirements to higher levels and to enable the athletes in the groundwork who are new to basketball to show top-level performance in the future is through the improvement of the parameters we have discussed. Basketball coaches, especially those in groundwork, should not forget that they are the first molders of new assets to be redounded to basketball. Within this frame of mind, they should improve themselves and reflect this improvement on their athletes. Coaches should regularly take anthropometric measurements of their athletes and record the characteristics that develop based on the measurements. They should apply tests that can measure basketball skills to their athletes and record the skill development levels periodically and create a program to resolve the aspects the athlete is lacking.

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