ATATÜRK ÜNİVERSİTESİ YAYINLARI
ATATURK UNIVERSITY PUBLICATIONS

Research Article *Araştırma Makalesi* DOI: 10.62425/rses.1696027

Investigation of the Relationship Between Lower Extremity Anthropometric Characteristics and Some Selected Physical and Physiological Parameters of Volleyball Players in the University Team

Üniversite Takımında Yer Alan Voleybolcuların Alt Ekstremite Antropometrik Özellikler İle Seçilmiş Bazı Fiziksel ve Fizyolojik Parametreler Arasındaki İlişkinin İncelenmesi

Ahmet KOYUNLU[1]
[1]Kahramanmaraş Sütçü İmam University, Faculty of Sports Sciences, Department of Physical Education and Sports, Kahramanmaraş, Türkiye

Hüseyin EROĞLU[1]
[1]Kahramanmaraş Sütçü İmam University, Faculty of Sports Sciences, Department of Physical Education and Sports, Kahramanmaraş, Türkiye

ABSTRACT

Our study was conducted to investigate the relationship between lower extremity anthropometric characteristics and some selected physical and physiological parameters of man's volleyball players in the university team. n: 12 (age: 20.67±2.42) volleyball players from Kahramanmaraş Sütçü İmam University volleyball team were included in the study on a voluntary basis. To determine the lower extremity anthropometric characteristics, femoral bicondular diameter (using caliper), calf circumference, foot width, knee circumference and ankle circumference measurements were made, upper leg circumference, foot length, total leg length, lower leg length, upper leg length (using a non-flexible tape measure), and to determine the physical and physiological parameters, leg strength, vertical jump, standing long jump, 30-meter speed and balance measurements were made. As a result of the measurements and analyses performed, it was determined that there was a moderate positive correlation between leg strength and knee circumference, a moderate positive correlation between 30-meter sprint performance time and ankle circumference, a high positive correlation between right foot balance score and total leg length, a moderate positive correlation between lower leg length and ankle circumference, and a moderate positive correlation between left foot balance score and foot width and knee circumference (p<.05). As a result; it can be said that the lower extremity anthropometric characteristics of volleyball players affect some physical and physiological parameters, especially the increase in knee circumference positively affects leg strength, and balance performance is negatively affected as the whole leg length and lower leg length increase.

Keywords: Lower extremity, anthropometric characteristics, physical and physiological parameters, volleyball

ÖZ

Çalışmamız üniversite takımında yer alan voleybolcuların alt akstremite antropometrik özellikler ile seçilmiş bazı fiziksel ve fizyolojik parametreler arasındaki ilişkinin incelenmesi amacıyla yapılmıştır. Çalışmaya Kahramanmaraş Sütçü İmam Üniversitesi erkek voleybol takımında yer alan n:12 (yaş: 20,67±2,42) voleybolcu gönüllülük ilkesine göre dâhil edilmiştir. Alt akstremite antropometrik özelliklerin belirlenmesi için femoral bikondüler çap (kaliper kullanılarak), calf çevresi, ayak genişliği, diz çevresi ve ayak bileği çevresi ölçümleri üst bacak çevresi, ayak uzunluğu, tüm bacak boyu, alt bacak boyu, üst bacak boyu (esnek olmayan mezura kullanılarak), fiziksel ve fizyolojik parametrelerin belirlenmesi için ise bacak kuvveti, dikey sıçrama, durarak uzun atlama, 30 metre sürat ve denge ölçümleri yapılmıştır. Gerçekleştirilen ölçüm ve analizler neticesinde, bacak kuvveti ile diz çevresi arasında orta düzey pozitif korelasyon, 30 metre sürat performans süresi ile ayak bileği çevresi arasında orta düzey pozitif korelasyon, sağ ayak denge skoru ile tüm bacak boyu arasında yüksek düzey pozitif korelasyon, alt bacak boyu ve ayak bileği çevresi arasında orta düzey pozitif korelasyon; sol ayak denge skoru ile ayak genişliği ve diz çevresi arasında orta düzey pozitif korelasyon olduğu (p<,05) tespit edilmiştir. Sonuç olarak; voleybolcuların alt ektremite antropometrik özelliklerinin bazı fiziksel ve fizyolojik parametrelere etki ettiği özellikle diz çevre genişliğinin artması ile bacak kuvvetinin olumlu etkilediği, tüm bacak boyu ve alt bacak boyu uzadıkça denge performansı olumsuz yönde etkilendiği söylenebilir.

Anahtar Kelimeler: Alt ekstremite, antropometrik özellikler, fiziksel ve fizyolojik parametreler, voleybol

Geliş Tarihi/Received 09.05.2025
Kabul Tarihi/Accepted 10.10.2025
Yayın Tarihi/Publication Date 25.12.2025

Sorumlu Yazar/Corresponding author: Ahmet KOYUNLU
E-mail: koyunluahmet@gmail.com
Cite this article: Koyunlu, A., & Eroğlu, H. (2025). Investigation of the relationship between lower extremity anthropometric characteristics and some selected physical and physiological parameters of volleyball players in the university team. *Research in Sport Education and Sciences, 27*(4), 289-300.

Introduction

In order to be successful in sports and remain successful, the physical, physiological and anthropometric characteristics required by the sports discipline must be at the expected level. Therefore, it is aimed to determine the most appropriate physical, physiological and anthropometric characteristics for sports disciplines with the data obtained from the results of studies conducted on high-level athletes in recent years (Basu et al., 2019; Ćaćić et al., 2020; Pena et al., 2018; Sporis et al., 2009). Determining the characteristics required by sports disciplines, identifying possible deficiencies in individuals who are interested in these sports, and eliminating these deficiencies with training programs to be implemented constitute the basic basis of training science (Barlow et al., 2014).

Physical, physiological and morphological characteristics must also be taken into account in the performance evaluation of athletes. Sporcular üzerinde gerçekleştirilen birçok araştırma fiziksel ve fizyolojik özelliklerin sportif performansı etkilediğini belirtmektedir. If the physiological structure of athletes does not contain the characteristics required by the sports discipline, it is very difficult to exhibit the expected performance. Therefore, if a high level of success is demanded in the sports branch, the anthropometric characteristics, physical and physiological characteristics required for the sports branch must be well developed **(**Marta, et al., 2013; Massidda et al., 2013; Wilber & Pitsiladis, 2012). Physical and physiological characteristics (strength, flexibility, speed, endurance and agility) combine with different factors affecting performance to produce highly effective results on the performance of athletes (Barlow et al., 2014).

In volleyball, where short loads and rests are included, muscle strength, aerobic and anaerobic abilities must be at a high level (Sporis et al., 2009). Volleyball is a sport preferred by university students because it contains many physiological characteristics for the application of the techniques and because the feeling of competition is experienced at a very high level (Ostojic et al., 2006). The physical, physiological and anthropometric characteristics of high-level volleyball players have been determined by research, but reference studies on school teams in which university students participate are limited (Kausar et al., 2015; Koley et al., 2010). Studies on this subject are mostly limited to volleyball-specific features (Ziv & Lidor, 2009).

For all these reasons, this study was planned to examine the relationship between the lower extremity anthropometric characteristics of volleyball players in the university team and some selected physical and physiological parameters and to provide a reference for future studies with the results.

Methods

Participants

Athletes from Kahramanmaraş Sütçü Imam University men's volleyball team, n: 12 (age: 20.67±2.42), were included in the study. All athletes participated in the study voluntarily, for this reason, the athletes signed an informed consent form and the necessary permissions for the study were obtained from the Kahramanmaraş Sütçü İmam University Medical Research Ethics Committee (Date: January 13, 2025, Decision Number: 03, Protocol No: 354). Before the physical and physiological parameter tests to be applied to the athletes, they were informed about the plan and purpose of the study, necessary warm-up procedures were applied to prevent any injuries, and the study was completed by doing cool-down exercises after the tests.

Determination of lower extremity anthropometric characteristics

Lower extremity anthropometric characteristics were measured as femoral bicondylar diameter (using caliper), total leg length, lower leg length, upper leg length, calf circumference, upper leg circumference, foot length, foot width, knee circumference and ankle circumference (using a non-flexible tape measure). The measurements were made in anatomical posture and from the right side of the body.

Femoral bicondylar diameter; The width between the medial and lateral epicondyles of the femoral bone was determined by measuring with a caliper, with the athletes sitting on a chair and their knees flexed at 90^0 degrees (Bingül et al., 2022).

Total leg length; Total leg length of volleyball players was determined by measuring the distance between spina iliaca

anterior superior and medial malleolus (Olmez et al., 2022).

Lower leg length; It was determined by measuring the distance between the middle of the proximal tibia and the sole of the foot with a tape measure (Plisky, et al., 2009; Ruffe et al., 2019).

Upper leg length; It was determined by measuring the distance between the trochanter major of the femoral and the condylus medialis of the tibia with a tape measure (Plisky, et al., 2009; Ruffe et al., 2019).

Calf circumference; Gastrocnemius was determined by measuring from the point where the highest result could be obtained (Kurt et al., 2023).

Upper leg circumference; It was determined by taking measurements just below the gluteal region and 10-15 cm above the patella (Kaya et al, 2020).

Foot length; It was determined by measuring the distance between the most protruding point at the back of the calcaneus and the farthest distal finger (1st or 2nd finger) phalanx distalis (Doğruyol & Çimen, 2020).

Foot width; It was determined by measuring the distance between the most protruding points of the 1st and 5th metacarpal bones (Bingöl et al., 2023).

Knee circumference; It was determined by measuring from the point on the patella where the highest result can be obtained (Bingöl et al., 2023).

Ankle circumference; It was determined by measuring with a tape measure over the ankle joint (Bingöl et al., 2023).

Determination of physical and physiological parameters

Leg strength test; It was carried out using a back and leg (Takei-Back & Lift) dynamometer. During the measurement, volleyball players were reminded that in order to clearly determine the leg strength, the bar should be pulled using only the legs, without using the back and arms, and the highest measurement value was recorded as kg by performing three repetitions (Yarayan & Muniroglu, 2020).

Vertical jump test; The athlete was in a sideways position and the distance up to where his arm could reach without leaving the sole of his foot off the ground was marked, the fingertip was dusted with chalk without jumping, the highest point he could reach by jumping was determined and the distance between the first reach point and the last point that could be reached before the test was recorded as the test result in cm ((Bilgiç & Koyunlu, 2024; Yarayan & Muniroglu, 2020).

Standing long jump test; Athletes were asked to jump at their highest performance by swinging their arms forward and backward on a non-slippery and flat surface with their toes on a determined line, and the distance between the starting point and the last point where they fell (the heel closest to the starting point) was measured and recorded in cm (Şahin et al 2022).

30-meter speed test; speed performance measurements were carried out on a 30-meter, non-slippery, flat area. A double-door photocell was used to determine the performance value. Athletes waited in front of the exit gate in a high start position and started the test when they felt ready. The photocell started when they passed through the entrance gate and ended when they passed through the exit gate. Athletes were given two attempts and the best time was recorded in seconds (Yavuz et al., 2023).

Balance performance test; A portable balance measuring device (Togu Challenge Disc 2.0, Prien am Chiemsee, Rosenheim, Germany) was used to determine the balance performance of the athletes. The data of this device is scored between 1-5, and the lower the score, the better the balance. The device was connected to the computer environment via Bluetooth, the computer was placed in an area where the athletes could easily see it, and measurements were made on the right foot, left foot and both feet, with bare feet, and the results were recorded (Acar, et al., 2024).

Statistical Analysis

The information gotten at the conclusion of the investigate; Exceed expectations program (Microsoft Office, form 2013, Microsoft Corp., Redmond, WA, USA) was utilized for classification and calculation of rate contrasts, and SPSS bundle program (SPSS for Windows, form 22.0, SPSS Inc., Chicago, Illinois, USA) was utilized for measurable investigation. Information were displayed as cruel and standard deviation. Shapiro-Wilk test was connected for typicality test. Skewness and kurtosis values were checked for information sets that did not appear ordinary conveyance, and information sets with a esteem of ±2 were acknowledged to appear typical dispersion. Measurable comes about were assessed at 0.05 centrality levels. The relationship between the information was inspected with Pearson relationship test.

Results

Table 1.
Demographic characteristics of the athletes participating in the study

Variables		N	Min	Max	Mean	SD
Demographic Information	Age (years)	12	17.00	26.00	20.67	2.42
	Sports Age (years)		1.00	14.00	6.50	3.94
	Height (cm)		170.00	197.00	182.50	8.26
	Body Weight (kg)		59.00	100.00	77.08	13.69
	BMI (kg/m^2)		19.01	28.33	23.04	2.96

Min: Minimum; Max: Maksımum; SD: standart deviation

A total of 12 athletes (age: 20.67±2.42) from the Kahramanmaraş Sütçü Imam University men's volleyball team were included in our study. The demographic characteristics of the group are given in Table 1.

Table 2.
Relationship between demographic information and physical and physiological parameters of the athletes participating in the study

		Leg strength (kg)	Vertical jump (cm)	Standing Long Jump (cm)	30 meters Speed (sec)	Right Foot Balance Score	Left Foot Balance Score	Double Leg Balance Score
Age (years)	r	**-0.631**	-0.203	-0.360	0.348	-0.321	-0.537	-0.059
	p	**.028***	.527	.250	.267	.309	.072	.856
Sports Age (years)	r	0.036	0.164	-0.092	0.343	0.545	0.068	0.153
	p	.912	.611	.777	.275	.067	.833	.635
Height (cm)	r	0.433	-0.324	-0.088	0.232	0.470	**0.709**	**0.708**
	p	.159	.304	.785	.468	.123	**.010***	**.010***
Body Weight (kg)	r	0.377	**-0.594**	**-0.613**	**0.633**	**0.641**	0.486	**0.794**
	p	.226	**.042***	**.034***	**.027***	**.025***	.109	**.002***
BMI (kg/m^2)	r	0.211	**-0.609**	**-0.789**	**0.703**	0.531	0.166	**0.593**
	p	.510	**.036***	**.002***	**.011***	.076	.606	**.042***
Leg strength (kg)	r	1	0.022	0.189	-0.328	0.202	0.324	0.320
	p		.947	.556	.298	.529	.304	.311
Vertical jump (cm)	r		1	**0.832**	**-0.638**	-0.251	-0.139	-0.536
	p			**.001***	**.025***	.432	.668	.073

Standing Long Jump (cm)	r	1	**-0.794**	-0.213	0.068	-0.365
	p		**.002***	.506	.835	.243
30 meters Speed (sec)	r		1	0.419	-0.084	**0.596**
	p			.175	.796	**.041***
Right Foot Balance Score	r			1	**0.592**	**0.622**
	p				**.042***	**.031***
Left Foot Balance Score	r				1	0.378
	p					.226
Double Leg Balance Score	r					1
	p					

*p<.05; cm: centimeter; kg; kilogram; sec: second.

When the relationship between the demographic information of the athletes in Table 2 and their physical and physiological parameters is examined, it is determined that as age increases, there is a decrease in the leg strength of the athletes, as height increases, there is an increase in the right foot balance score and double foot balance score, as weight increases, there is a decrease in vertical jump, standing long jump, 30-meter sprint performance, and an increase in right and double foot balance scores, as BMI increases, there is an increase in vertical jump, standing long jump performance, 30-meter sprint and double foot balance scores, as vertical jump performance increases, there is an increase in standing long jump and 30-meter sprint performance, as standing long jump performance increases, there is an increase in 30-meter sprint performance, as 30-meter sprint performance increases, there is an increase in double foot balance score, and as the right foot balance score increases, there is an increase in left and double foot balance scores.

Table 3.
Relationship between demographic information and lower extremity anthropometric characteristics of the athletes participating in the study

		Femoral Bicondylar Diameter (cm)	Total Leg Length (cm)	Lower Leg Length (cm)	Upper Leg Length (sec)	Calf Circumference (cm)	Upper Leg Circumference (cm)	Foot Length (cm)	Foot Width (cm)	Knee Circumference (cm)	Ankle Circumference (cm)
Age (years)	r	-0.337	-0.392	-0.333	-0.219	-0.469	-0.334	-0.275	-0.485	-0.564	-0.284
	p	.284	.207	.290	.494	.124	.289	.387	.110	.056	.371
Sports Age (years)	r	0.449	0.171	0.381	-0.200	0.316	0.158	-0.014	-0.157	0.356	0.298
	p	.143	.595	.221	.532	.317	.625	.966	.627	.257	.348
Height (cm)	r	0.483	**0.880**	**0.660**	**0.600**	**0.651**	0.533	0.545	0.267	**0.577**	0.574
	p	.112	**.001***	**.020***	**.039***	**.022***	.075	.067	.401	**.049***	.051
Body Weight (kg)	r	**0.746**	**0.807**	**0.867**	0.222	**0.644**	**0.736**	0.362	0.186	**0.691**	**0.667**
	p	**.005***	**.002***	**.001***	.488	**.024***	**.006***	.247	.563	**.013***	**.018***
BMI (kg/m^2)	r	**0.682**	0.486	**0.708**	-0.099	0.427	**0.634**	0.121	0.083	0.536	0.506
	p	**.015***	.109	**.010***	.759	.166	**.027***	.709	.798	.072	.093
Femoral Bicondylar Diameter (cm)	r	1	**0.642**	**0.669**	0.202	**0.832**	**0.656**	0.437	0.438	**0.891**	**0.714**
	p		**.024***	**.017***	.529	**.001***	**.021***	.155	.154	**.001***	**.009***
Total Leg Length (cm)	r		1	**0.787**	**0.634**	**0.616**	**0.766**	0.559	0.417	**0.734**	**0.785**
	p			**.002***	**.027***	**.033***	**.004***	.059	.177	**.007***	**.003***
Lower Leg Length (cm)	r			1	0.023	**0.579**	**0.774**	0.541	0.300	**0.765**	**0.688**
	p				.943	**.048***	**.003***	.069	.343	**.004***	**.013***
Upper Leg Length (sec)	r				1	00.273	0.272	0.227	0.300	0.230	0.410
	p					.391	.393	.477	.343	.471	.185

Calf Circumference (cm)	r	1	0.370	0.570	0.342	**0.693**	0.482
	p		.237	.053	.277	**.013***	.112
Upper Leg Circumference (cm)	r		1	0.210	**0.600**	**0.821**	**0.733**
	p			.512	**.039***	**.001***	**.007***
Foot Length (cm)	r			1	0.270	0.530	0.531
	p				.395	.076	.075
Foot Width (cm)	r				1	**0.613**	0.282
	p					**.034***	.374
Knee Circumference (cm)	r					1	**0.813**
	p						**.001***
Ankle Circumference (cm)	r						1
	p						

*p<.05; cm: centimeter; kg; kilogram; sec: second.

When the relationship between the demographic information of the athletes in Table 3 and the lower extremity anthropometric features was examined, it was seen that as the height increased, there was an increase in the athletes' whole leg length, lower leg length, upper leg length, calf circumference and knee circumference; as the weight increased, there was an increase in the athletes' femoral bicondylar diameter, whole leg length, lower leg length, calf circumference, upper leg circumference, knee circumference and ankle circumference; as the BMI increased, there was an increase in the femoral bicondylar diameter, lower leg length and upper leg circumference; as the femoral bicondylar diameter increased, there was an increase in the whole leg length, lower leg length, calf circumference, upper leg circumference, knee circumference and ankle circumference; as the whole leg length increased, there was an increase in the lower leg length, upper leg length, calf circumference, upper leg circumference, knee circumference and ankle circumference; as the lower leg length increased, there was an increase in the calf circumference, upper leg circumference, knee circumference and ankle circumference; as the calf circumference increased, there was an increase in the knee circumference; as the upper leg circumference increased, there was an increase in the foot width, knee circumference and ankle circumference; as the foot width increased, there was an increase in the knee circumference; It has been determined that as the knee circumference increases, the ankle circumference also increases. It was determined that there was a decrease in leg strength, as height increased, there was an increase in right foot balance score and double foot balance score, as weight increased, there was a decrease in vertical jump, standing long jump, 30-meter sprint performance, and an increase in right and double foot balance scores, as BMI increased, there was an increase in vertical jump, standing long jump performance, an increase in 30-meter sprint and double foot balance scores, as vertical jump performance increased, there was an increase in standing long jump and 30-meter sprint performance, as standing long jump performance increased, there was an increase in 30-meter sprint performance, as 30-meter sprint performance increased, there was an increase in double foot balance score, as the right foot balance score increased, there was an increase in left and double foot balance scores.

Table 4.
Relationship between physical and physiological parameters and lower extremity anthropometric features of the athletes participating in the study

		Femoral Bicondylar Diameter (cm)	Total Leg Length (cm)	Lower Leg Length (cm)	Upper Leg Length (sec)	Calf Circumference (cm)	Upper Leg Circumference (cm)	Foot Length (cm)	Foot Width (cm)	Knee Circumference (cm)	Ankle Circumference (cm)
Leg strength (kg)	r	0.422	0.326	0.443	-0.027	0.403	0.497	0.222	0.621	**0.582**	0.084
	p	.171	.301	.149	.933	.194	.100	.487	.031	**.047***	.794
Vertical jump (cm)	r	-0.347	-0.471	-0.529	-0.100	-0.283	-0.427	-0.528	-0.055	-0.350	-0.543
	p	.269	.122	.077	.757	.372	.166	.078	.866	.265	.068

Standing Long Jump (cm)	r	-0.392	-0.292	-0.426	0.061	-0.237	-0.354	-0.172	0.048	-0.230	-0.431
	p	.208	.357	.167	.852	.459	.259	.593	.883	.473	.162
30 meters Speed (sec)	r	0.534	0.431	0.460	0.123	0.382	0.233	0.376	-0.229	0.302	**0.595**
	p	.074	.162	.133	.704	.221	.466	.228	.474	.339	**.041***
Right Foot Balance Score	r	0.563	**0.768**	**0.659**	0.419	0.447	0.529	0.528	0.054	0.545	**0.613**
	p	.057	**.004***	**.020***	.175	.145	.077	.077	.868	.067	**.034***
Left Foot Balance Score	r	0.422	0.326	0.443	-0.027	0.403	0.497	0.222	**0.621**	**0.582**	0.084
	p	.171	.301	.149	.933	.194	.100	.487	**.031***	**.047***	.794
Double Leg Balance Score	r	-0.347	-0.471	-0.529	-0.100	-0.283	-0.427	-0.528	-0.055	-0.350	-0.543
	p	.269	.122	.077	.757	.372	.166	.078	.866	.265	.068

*p<.05; cm: centimeter; kg; kilogram; sec: second.

When the relationship between the physical and physiological parameters of the athletes in Table 4 and the lower extremity anthropometric features was examined, it was determined that as the leg strength increased, there was an increase in the knee circumference, as the 30-meter sprint performance time (sec) increased, there was an increase in the ankle circumference, as the right foot balance score increased, there was an increase in the whole leg length, lower leg length and ankle circumference, and as the left foot balance score increased, there was an increase in the foot width and knee circumference.

A moderate positive correlation was found between leg strength and knee circumference; a moderate positive correlation was found between 30-meter sprint performance time (sec) and ankle circumference; a high positive correlation was found between right foot balance score and total leg length, a moderate positive correlation was found between lower leg length and ankle circumference; and a moderate positive correlation was found between left foot balance score and foot width and knee circumference (p<.05).

Discussion

Comprehensive analysis and consideration of the anatomical and physiological characteristics of the body allows the training of highly qualified athletes, since the features of the external structure of the athlete's body are a prerequisite for the realization of his physical abilities. The results of the evaluation of anthropometric characteristics will allow the creation of profiles of elite athletes in certain sports branches and these profiles can be used as a training criterion for beginners (Sarafyniuk at al., 2024). It is reported that body composition and structure are structured based on genetic factors, types of sports and the content of the training performed (Arden & Spector, 1997).

It was found that there was a moderate negative correlation between age and leg strength; a high positive correlation between height and right foot balance score, a high positive correlation between double foot balance score; a moderate negative correlation between weight and vertical jump, a moderate negative correlation between standing long jump, a moderate positive correlation between 30-meter sprint, a moderate positive correlation between right foot balance score, a high positive correlation between double foot balance score; a moderate negative correlation between BMI and vertical jump, a high negative correlation between standing long jump, a high positive correlation between 30-meter sprint, a moderate positive correlation between double foot balance score; a high positive correlation between vertical jump and standing long jump performance, a moderate negative correlation between 30-meter sprint; a high negative correlation between standing long jump and 30-meter sprint; a moderate positive correlation between 30-meter sprint and double foot balance score; a moderate positive correlation between right foot balance score and left foot balance score, and a moderate positive correlation between double foot balance score (p<.05).

Height is a prominent feature within volleyball, often seen as a defining characteristic associated with dominant players who can block attacks and spike with authority. Height provides an undeniable advantage in certain aspects of the game Palani et al., 2024).

Volleyball could be a group wear with exceedingly discontinuous particular assignments that require distinctive physiological components and multi-directional court developments that happen over and over amid competition. Amid volleyball play, a few maximal and high-intensity muscle developments are required depending on the player's position on the court and obligations (e.g. bouncing, passing, assaulting, blocking, running, and quickly changing beat). Volleyball players

take part in tedious brief and high-intensity volleyball errands (i.e. in both vertical and flat headings), taken after by periods of low-intensity movement and brief recuperation periods between each rally point. The high-intensity work out periods incorporate a great level of wellness to back the endeavors that basically require high-impact and anaerobic vitality frameworks. Volleyball is considered a power-dominant don, as can be seen by the players bouncing tall or hitting the ball effectively. Therefore, volleyball training focuses more on strength training and muscle building rather than endurance training. The development of leg strength is also the basis of these strength trainings. The reason why leg strength is considered a very important feature in volleyball is that the player needs leg strength to be able to jump very high and to be able to serve by jumping. Serving is the most important skill in the game as it determines the tempo and momentum of the game. It was determined that there was an inverse relationship between mass and jump height, and a direct relationship between body height and jump height. Regarding the throwing angle of BMI, it was determined that there was a direct relationship between the knee angle and the throwing angle, and an inverse relationship between the ankle angle and the minimum height and the ball throwing angle (ALHammouri & Ismail, 2023).

High level positive correlation between height and total leg length, moderate level positive correlation between lower leg length, upper leg length, calf circumference and knee circumference; high level positive correlation between weight and femoral bicondylar diameter, total leg length, lower leg length, upper leg circumference and knee circumference, moderate level positive correlation between calf circumference and ankle circumference; there was a moderate positive correlation between BMI and femoral bicondylar diameter and upper leg circumference, and a high positive correlation between lower leg length; moderate correlation between femoral bicuspid diameter and total leg length, lower leg length and upper leg circumference, high positive correlation between calf circumference, knee circumference and ankle circumference; high level positive correlation between total leg length and lower leg length, upper leg circumference, knee circumference and ankle circumference, moderate level positive correlation between upper leg length and calf circumference; moderate positive correlation between lower leg length and calf circumference and ankle circumference, high positive correlation between upper leg circumference and knee circumference; It was determined that there was a moderate positive correlation between calf circumference and knee circumference; a moderate positive correlation between upper leg circumference and foot width; a high positive correlation between knee circumference and ankle circumference; a moderate positive correlation between foot width and knee circumference; and a high positive correlation between knee circumference and ankle circumference (p<.05).

It has been reported that players' height, spike height and block height have the most impact on a team's ranking in world championships (Jahandideh et al., 2021). A study whose aim was to determine anatomical differences in physical characteristics and muscle strength among university athletes in Nigeria reported that palm width, hand length and finger length showed a strong positive correlation with height (Kingdom et al., 2023).

A moderate positive correlation was found between leg strength and knee circumference; a moderate positive correlation was found between 30-meter sprint performance time (sec) and ankle circumference; a high positive correlation was found between right foot balance score and total leg length, a moderate positive correlation was found between lower leg length and ankle circumference; and a moderate positive correlation was found between left foot balance score and foot width and knee circumference (p<.05).

Systematic volleyball training has a significant effect on the somatometric characteristics of the upper and lower extremities; this is evidenced by the presence of significant differences in the values of these indicators between groups of volleyball players and non-athletes. It was determined that all transverse and circumferential dimensions of the upper and lower extremities of the volleyball players in the general group were larger (p<.01-.001) compared to the girls in the control group (Sarafyniuk et al., 2024). Physical condition is necessary for the body to be ready to complete the match that is being played. Also, physical condition is very decisive for athletes to optimize the techniques they learn in beach volleyball games. Physical conditions will also affect body composition. According to Tomaç et al., explosive power and strength factors are greatly affected by the body composition of each athlete. Therefore, beach volleyball game requires good physique in terms of body composition. Body composition greatly influences the level of physical capacity of athletes and can also be determined by body composition, especially muscle mass and body fat, in terms of explosive power. Maximum strength and performance characteristics and body composition are the main factors affecting explosive power and performance. Body composition is important for performance and power. It has been suggested that there is a significant relationship between body

composition and the explosive power of the lower extremity muscles and upper extremities in beach volleyball athletes (Bahauddin et al., 2024).

When Table 2 is examined, it is seen that as body weight increases, there is a decrease in vertical jump, standing long jump, 30-meter sprint performance and an increase in right and double-foot balance scores.

Together with stature, body weight too gets to be imperative within the physical structure of volleyball competitors. The capacity to produce unstable control, which is basic for effective jumping and spiking, is frequently related with body mass. Body mass file (BMI) may be a degree that reflects the relationship between weight and tallness and gives an sign of overall body composition. It goes past physical estimate alone and gives experiences into variables such as muscle mass, dissemination, and proportionality that will influence bounce stature in volleyball players. Understanding the complex connect between BMI and hop stature can give important experiences into the perfect physiological conditions for top athletic execution. The positive relationship between body weight and bounce stature recommends that players with more noteworthy body mass tend to realize more prominent vertical relocation amid hops, likely reflecting more noteworthy muscle mass and quality within the lower limits (Palani et al., 2024).

There is a moderate negative correlation between BMI and vertical jump (Table 2).

The negative relationship between BMI and bounce stature infers that players with higher BMI may involvement marginally lower bounce statures, which may reflect contrasts in body composition and muscle-fat proportion (Palani et al., 2024). It is well known that certain physical characteristics or anthropometric profiles demonstrate whether a player is fit to compete at the most noteworthy level in a specific wear. These anthropometric and morphological parameters are delicate pointers of competitors physical development and dietary status for most extreme execution. Numerous considers have inspected the connections between anthropometric and physiological characteristics of volleyball players. The discoveries of these thinks about have appeared that certain anthropometric characteristics such as more prominent stature, more prominent vertical bounce remove, more prominent mass, more prominent upper body quality, and lower body fat rate are profitable for volleyball players (Koley et al., 2010).

There is a significant relationship between vertical jumps and weight, leg length, maximum calf circumference, foot length for spikers and point guards, as well as tight circumference and weight for liberos. However, anthropometric parameters are effective in vertical jumps in different playing positions in volleyball players. For volleyball players, due to the playing position, it seems necessary to take into account the training methods as well as the anthropometric parameters (Fattahi et al., 2012). It can be concluded that hand grip strength has strong positive correlations with the height and weight of volleyball players (Pavlović et al., 2023).

It is accepted that the strength of the lower extremities is significantly related to the characteristics describing the shoulder girdle circumference and bone mass. Morphological predispositions often determine a player's functional abilities. In volleyball, strength and speed training leads to changes in muscle mass, endurance, strength, power, and jumping abilities. The height of the vertical jump in volleyball players is determined by a certain level of strength, which also affects their efficiency (Pietraszewska et al., 2015). Structural variables related to bone dimensions, both longitudinal and transverse, adiposity and muscle development are predictive factors of performance in physical fitness tests. Performance in flexibility tests is more dependent on bone structure, jumping performance is more dependent on both adiposity and bone structure, and sprint and agility performance is more dependent on adiposity (Albaladejo-Saura et al., 2022).

In volleyball, the most characteristics that characterize players are hopping capacity, control yield and quality. Moreover, the anthropometric characteristics of competitors can impact the level of execution and offer assistance decide a appropriate physical make-up for a given wear. Agreeing to Giannopoulos et al., around 24% of the hostile execution of volleyball players can be anticipated by the direct combination of somatotype and muscle quality. The rate of incline mass is related with changes in lower body quality connected in perseverance works out, the capacity to rehash sprints and the capacity to perform a few sorts of hops included in these sports disciplines. Incline body mass is an vital determinant of quality for athletic execution. Overabundance fat mass disables quality, particularly lower limit execution and perseverance (Miguel-Ortega, et al., 2023).

Lower extremity strength is statistically significant on EF serve (effective serve) in men's volleyball, but it can be said to have a moderate effect. Lower extremity strength varies among players in different positions and may be related to their on-court function; for example, outside hitters are forced to attack from deep in the court, so their lower extremity strength must be and is relatively greater than that of players playing other positions (Bobula et al., 2024). A study on volleyball players reported that body weight and body mass, standing with one arm, standing with two arms, arm span, explosive power, agility, speed and flexibility significantly affect performance, affecting the anthropometric characteristics and motor abilities of a player's position (Milić et al., 2024). The longer leverage provided by extended leg length can generate greater force and translate into higher jumps. This information is particularly important in sports where jumping ability is a critical skill and guides both talent identification and training methods (Pavlovic et al., 2024). In a study, a positive correlation was observed between explosive power and body composition and motor abilities in the variables of height and body weight, while body fat percentage and muscle mass percentage were stated to be positively correlated with agility (Ilić et al., 2023).

Conclusion and Recommendations

As a result; it can be said that the lower extremity anthropometric characteristics of male volleyball players affect some physical and physiological parameters, balance scores increase as height increases, explosive strength increases as body weight increases, speed and balance scores increase as body weight increases, explosive strength values increase as BMI value decreases, speed and double-foot balance scores increase as BMI value increases, some lower extremity lengths and circumference values increase as height, body weight and BMI values increase, leg strength is positively affected by increasing knee circumference width, balance performance is negatively affected as whole leg length and lower leg length increase.

Based on this study, we recommend increasing the number of participants in the study group and examining the upper extremity characteristics of volleyball players according to their gender and the regions they play.

Etik Komite Onayı: Bu çalışma için etik komite onayı Kahramanmaraş Sütçü İmam Üniversitesi'nden (Tarih: 13 Ocak 2025, Karar No: 03, Protokol No: 354) alınmıştır.
Hasta Onamı: Çalışmaya katılan tüm katılımcılardan sözlü onam alınmıştır.
Hakem Değerlendirmesi: Dış bağımsız.
Yazar Katkıları: Fikir- A.K; Tasarım- A.K., H.E; Denetleme- A.K., H.E; Kaynaklar- A.K., H.E; Veri Toplanması ve/veya İşlemesi A.K., H.E; Analiz ve/ veya Yorum- A.K; Literatür Taraması- A.K., H.E; Yazıyı Yazan- A.K., H.E; Eleştirel İnceleme- A.K., H.E; Diğer- A.K., H.E.
Çıkar Çatışması: Yazarlar, çıkar çatışması olmadığını beyan etmiştir.
Finansal Destek: Yazarlar, bu çalışma için finansal destek almadığını beyan etmiştir.
Yapay Zekâ Kullanımı: Çalışmanın herhangi bir aşamasında yapay zekâ araçlarından yararlanılmamıştır.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Kahramanmaraş Sütçü İmam University (Date: January 13, 2025, Decision Number: 03, Protocol No: 354).
Informed Consent: Verbal consent was obtained from all the participants.
Peer-review: Externally peer-reviewed.
Author Contributions: Concept –A.K; Design- A.K., H.E; Supervision- A.K., H.E; Resources- A.K., H.E; Data Collection and/or Processing- A.K., H.E; Analysis and/or Interpretation- A.K; Literature Search- A.K., H.E; Writing Manuscript- A.K., H.E; Critical Review- A.K., H.E; Other- A.K., H.E.
Conflict of Interest: The authors have no conflicts of interest to declare.
Financial Disclosure: The authors declared that this study has received no financial support.
Use of Artificial Intelligence: Artificial intelligence tools were not used at any stage of the study.

References

Acar, K., Mor, A., Mor, H., Karakaş, F., Yılmaz, A. K., & Arslanoğlu, E. (2024). Yüzücülerde dayanıklılık antrenmanının sıvı dengesi ve performans parametrelerine etkisi. [The effect of durability training on swimmers on fluid balance and performance parameters]. *Gümüşhane Üniversitesi Sağlık Bilimleri Dergisi, 13*(1), 400-408.

Albaladejo-Saura, M., Vaquero-Cristóbal, R., García-Roca, J. A., & Esparza-Ros, F. (2022). Influence of maturity status on kinanthropometric and physical fitness variables in adolescent female volleyball players. *Appl. Sci., 12*(9), 4400. doi:https://doi.org/10.3390/app12094400

ALHammouri, W., & Ismail, W. B. (2023). The psychology of relationship between squat's kinematics' variables, anthropometric measurements and jump serve kinematics' variables amongst volleyball players. *Journal for Re Attach Therapy and Developmental Diversities, 6*(3s), 371-380.

Arden, N. K., & Spector, T. D. (1997). Genetic Influences on muscle strength, lean body mass, and bone mineral density: a twin study. *Journal of Bone and Mineral Research, 12*(12), 2076-2081.

Bahauddin, M. A., Al faini, A. R., Setiawan, B. A., Murtadho, M. M., Adib, M. A., & Maulana, R. (2024). C*orrelation between body composition and power performance in beach volleyball athletes*. In I. S. 2023) (A cura di). (p. 133-139). Atlantis Press.

Barlow, M. J., Findlay, M., Gresty, K., & Cooke, C. (2014). Anthropometric variables and their relationship to performance and ability in male surfers. *European journal of sport science, 14*(S1), S171-S177.

Basu, S., Roy, A. S., Dalui, R., & Bandyopadhyay, A. (2019). Physical fitness of basketball and volleyball players of kolkata, india. *Clinical and Experimental Physiology, 6*(4), 111-117.

Bilgiç, M., & Koyunlu, A. (2024). 12 haftalık yürüyüş temelli hareket eğitiminin seçilmiş motorik özelliklere etkisi. [The effect of 12 -week walk -based movement training on selected motoric characteristics]. *International Journal of Social and Humanities Sciences Research, 11*(114), 2588-2596. doi:https://doi.org/10.5281/zenodo.14522940

Bingöl, B., Saygın, Ö., & Salman, K. (2023). Yıldızlar kategorisi yüzücülerde seçilmiş antropometrik özelliklerin sprint yüzme performansına etkisinin incelenmesi. [Examining the effect of selected anthropometric characteristics on sprint swimming performance in star category swimmers] *Eurasian Research in Sport Science, 8*(2), 196-207. doi:10.29228/ERISS.40

Bingül, B. M., Menga, B., Köse, İ. E., & Bayrak, F. E. (2022). Farklı ülkelerin futbol oyuncularının somatotiplerinin ve vücut kompozisyonlarının karşılaştırılması. [Comparison of somato types and body compositions of football players of different countries]. *Journal of Sport and Recreation Researches, 4*(2), 30-41. doi:10.52272/srad.1207250

Bobula, G., Piech, J., Płonka, A., Król, P., Czarny, W., Pinto, R., . . . Bajorek, W. (2024). Evaluation of lower extremities power, movement, position and effectiveness in volleyball. *Appl. Sci, 14*(21), 10065. doi:https://doi.org/10.3390/app142110065

Ćaćić, I., Rupčić, T., Dukarić, V., Feng, L., & Cigrovski, V. (2020). Differences in motor abilities between female basketball and volleyball players. *Hrvatski športskomedicinski vjesnik, 35*(1-2), 41-45.

Doğruyol, G., & Çimen, M. (2020). Medial ve lateral ark açıları ile ayak uzunluğunun yaş, cinsiyet ve taraf farklılığı açısından radyolojik olarak incelenmesi. [Radiologically examination of medial and lateral arc openings and foot length in terms of age, gender and sides difference]. *Turkish Journal of Science and Health, 2*(1), 76-83.

Fattahi, A., Ameli, M., Sadeghi, H., & Mahmoodi, B. (2012). Relationship between anthropometric parameters with vertical jump in male elite volleyball players due to game's position. *Journal of human sport and Exercise, 7*(3), 714-726. doi:10.4100/jhse.2012.73.11

Ilić, T., Stojanović, S., & Mijalković, S. (2023). Body composition is related to motor abilities of female volleyball players. *Journal of Anthropology of Sport and Physical Education, 7*(2), 15-18.

Jahandideh, A., Rohani, H., & Hemmati, S. (2021). Anthropometric profile of fivb volleyball girls' u18 world championship volleyball players according to the playing position- world championship 2017. *International Journal of Sport, Exercise and Health Research, 5*(1), 23-27.

Kausar, A., Mudassir, S., Badaam, K. M., Shete, A. N., & Khan, S. (2015). Cardiorespiratory fitness of university volleyball players and sedentary young people in marathwada region of maharashtra province in india. *Journal of Clinical and Diagnostic Research, 9*(7), CC20-CC21. doi:10.7860/JCDR/2015/14361.6246

Kaya, M., Paktaş, Y., Topçu, İ., & Karabacak, E. (2020). Pilates reformer egzersizlerinin sedanter kadınlarda vücut ağırlığı, kas çevresi ve esneklik düzeylerine etkilerinin incelenmesi. [Investigation of the effects of Pilates reformer exercises on body weight, muscle circumference and flexibility levels in sedentary women]. *Sivas Cumhuriyet Üniversitesi Spor Bilimleri Dergisi, 1*(3), 130-139.

Kingdom, D. L., Barinem, V. W., Chinagorum, P. I., & Okon, E. S. (2023). The Correlation Between Body Extremities Morphometrics and Athletic Performance Among University Sports Students. *Journal of Morphological Sciences, 40*, 428. doi:10.51929/jms.40.428.2023

Koley, S., Singh, J., & Sandhu, J. S. (2010). Anthropometric and physiological characteristics on Indian inter-university volleyball players. *Journal of Human Sport and Exercise, 5*(3), 389-399. doi:doi:10.4100/jhse.2010.53.09

Kurt, E. İ., Varmış, N., Cengizel, Ç. Ö., & Cengizel, E. (2023). Havalı Tabanca ve havalı tüfek sporcularının somatotip, vücut yağ yüzdesi, üst ekstremite uzunluğu ve el kavrama kuvvetlerinin karşılaştırılması. [Comparison of somatotype, body fat percentage, upper extremity length and hand grip forces of air pistol and cool rifle athletes]. *SPORMETRE Beden Eğitimi ve Spor Bilimleri Dergisi, 21*(3), 190-201. doi:10.33689/spormetre.1300784

Marta, C. C., Marinho, D. A., Barbosa, T. M., Carneiro, A. L., Izquierdo, M., & Marques, M. C. (2013). Effects of body fat and dominant somatotype on explosive strength and aerobic capacity trainability in prepubescent children. *The Journal of Strength & Conditioning Research, 27*(12), 3233-3244.

Massidda, M., Toselli, S., Brasili, P., & Calo, C. M. (2013). Somatotype of elite italian gymnasts. *Collegium antropologicum, 37*(3), 853-857.

Miguel-Ortega, Á., Calleja-González, J., & Mielgo-Ayuso, J. (2023). Comparison of sports performance and kinanthropometric profiles of elite female basketball and volleyball players over the course of a competitive season. *Appl. Sci, 13*(14), 8267. doi:https://doi.org/10.3390/app13148267

Milić , M., Vukadinović, N., Grgantov, Z., Nikolić, K., Savić, Z., Majstorović, N., & Nešić, G. (2024). Basic anthropological characteristics of elite u17 youth serbian female volleyball players according to playing position. *Appl. Sci, 14*(23), 11197. doi: https://doi.org/10.3390/app142311197

Ostojic, S. M., Mazic, S., & Dikic, N. (2006). Profiling in basketball: Physical and physiological characteristics of elite players. *The Journal of Strength & Conditioning Research, 20*(4), 740-744.

Ölmez, C., Aydemir, B., & Ölmez, S. N. (2022). Taekwondoda tekme performansını etkileyen faktörlerin belirlenmesi. [Determination of factors affecting the kicking performance in Taekwondo]. *Akdeniz Spor Bilimleri Dergisi, 5*(2), 192-209. doi:10.38021/asbid.1095173

Palani, B., Raj, Y. C., & Sanjaykumar, S. (2024). Correlating anthropometric parameters with lower limb muscle strength: on the example of female volleyball players. *Physical Rehabilitation and Recreational Health Technologies, 9*(3), 113-122. doi:https://doi.org/10.15391/prrht.2024-9(3).02

Pavlovic, R., Joksimovic, M., Savic, V., Almutairi, H. J., Ahmad, F., Iqbal, A., & Alghadir, A. H. (2024). Comparative analysis of anthropometric attributes among bosnian and herzegovinian national volleyball team senior and junior male players: advancing insights into athletic development. *International Journal of Morphology, 42*(5), 1446-1453.

Pavlović, R., Radulović, N., Nikolić, S., & Savić, V. (2023). The influence of body height, body weight, body mass index on hand grip strength female volleyball player: Pilot study. *International Journal of Early Childhood Special Education, 14*(4), 104-112. doi:10.9756/INT-JECSE/V14I4.14

Pena, J., Moreno-Doutres, D., Coma, J., Cook, M., & Buscà, B. (2018). Anthropometric and fitness profile of high-level basketball, handball and volleyball players. *Revista Andaluza de Medicina del Deporte, 11*(1), 30-35. doi:doi.org/10.1016/j.ramd.2016.03.002

Pietraszewska, J., Burdukiewicz, A., Stachon, A., Andrzejewska, J., & Pietraszewski, B. (2015). Anthropometric characteristics and lower limb power of professional female volleyball players. *South African Journal for Research in Sport, Physical Education and Recreation, 37*(1), 99-112.

Plisky, P. J., Gorman, P. P., Butler, R. J., Kiesel, K. B., Underwood, F. B., & Elkins, B. (2009). The reliability of an instrumented device for measuring components of the star excursion balance test. *North American journal of sports physical therapy, 4*(2), 92-99.

Ruffe, N. J., Sorce, S. R., Rosenthal, M. D., & Rauh, M. J. (2019). Lower quarter-and upper quarter Y balance tests as predictors of running-related injuries in high school cross-country runners. *International journal of sports physical therapy, 14*(5), 695-706. doi:10.26603/ijspt20190695

Sarafyniuk, L., Stepanenko, I., Khapitska, O., Lezhnova, O., & Vlasenko, R. (2024). Anthropometric features of limbs in volleyball players of different somatotypes. *Bulletin of Medical and Biological Research, 6*(1), 52-63. doi:10.61751/bmbr/1.2024.52

Sporis, G., Jukic, I., Ostojic, S. M., & Milanoic, D. (2009). Fitness profiling in soccer:physical and physiologic characteristics of elite players. *Journal of Strength & Conditioning Research, 23*(7), 1947-1953.

Şahin, İ. H., Kahraman, Ö., Budak, M., & Kaplan, T. (2022). Adolesan futbolcularda esneklik ve durarak uzun atlamanın ivmelenme üzerine etkisi. [Flexibility in adolescent footballers and the effect of long jumping on acceleration]. *Spor ve Performans Araştırmaları Dergisi, 13*(3), 307-316.

Wilber, R. L., & Pitsiladis, Y. P. (2012). Kenyan and Ethiopian Distance Runners: What Makes Them So Good? *International Journal of Sports Physiology and Performance, 7*(2), 92-102.

Yarayan, M. T., & Müniroğlu, R. S. (2020). Sekiz haftalık pliometrik antrenman programının 13-14 yaş grubu futbolcularda dikey sıçrama, çeviklik, sürat ve kuvvet parametreleri üzerine etkisi. [The effect of eight-week plotometric training program on vertical jump, agility, speed and force parameters in 13-14 age group players]. *Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi, 18*(4), 100-112. doi:10.33689/spormetre.679445

Yavuz, M., Işıkdemir, E., & Metin, S. C. (2023). Futbolda temel eğitim alan çocuklarda sürat, çeviklik, denge ve dikey sıçrama performansı arasındaki ilişkinin incelenmesi. [Investigation of the relationship between speed, agility, balance and vertical jump performance in children with basic training in football.] *Uluslararası Bozok Spor Bilimleri Dergisi, 4*(1), 141-149.

Ziv, G., & Lidor, R. (2009). Physical characteristics, physiological attributes, and on-court performances of handball players: A review. *European Journal of Sport Science, 9*(6), 375-386. doi: 10.1080/17461390903038470