



ORİJİNAL MAKALE / ORIGINAL ARTICLE

Balıkesir Sağlık Bilimleri Dergisi / BAUN Sağ Bil Derg

Balıkesir Health Sciences Journal / BAUN Health Sci J

ISSN: 2146-9601- e ISSN: 2147-2238

Doi: <https://doi.org/10.53424/balikesirsbd.1863430>



Positional Differences in Anthropometric and Physical Fitness Characteristics Among Elite Male Basketball Players

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Geliş Tarihi / Received: 15.01.2026, Kabul Tarihi / Accepted: 12.05.2026

ABSTRACT

Objective: This study examined differences in anthropometric and selected physical fitness characteristics among elite male basketball players according to playing position. **Materials and Methods:** Eighty-one nationally competitive male players (age: 19.2±1.2 years) were classified as point guards, shooting guards, small forwards, power forwards, or centers. Measurements included body height, body mass, body mass index, limb segment lengths, handgrip strength, 10 m and 20 m sprint performance, jump performance (vertical jump [VJ] and countermovement jump [CMJ]), and flexibility. Data were analyzed using one-way analysis of variance (ANOVA) with Tukey post-hoc tests and Pearson correlation analysis. **Results:** Significant positional differences were found in height, body mass, body mass index, limb lengths, flexibility, age, and 20 m sprint performance ($p<0.05$). In contrast, no statistically significant differences were observed for handgrip strength, 10 m sprint performance, vertical jump (VJ), or countermovement jump (CMJ) ($p>0.05$). Centers and power forwards exhibited higher anthropometric values compared to other positions. Handgrip strength showed moderate positive correlations with hand and arm length ($r=0.31-0.41$). **Conclusion:** Elite male basketball players exhibit position-specific anthropometric characteristics, while some performance variables appear to be influenced more by individual factors than positional roles. These findings may support the design and optimization of position-specific training and performance strategies.

Keywords: Basketball, Anthropometry, Playing Position, Physical Fitness.

Elit Erkek Basketbolcularda Oyun Pozisyonuna Göre Antropometrik ve Fiziksel Uygunluk Farklılıkları

ÖZ

Amaç: Bu çalışmada elit erkek basketbolcularda oyun pozisyonuna göre antropometrik ve seçilmiş fiziksel uygunluk özelliklerindeki farklılıklar incelenmiştir. **Gereç ve Yöntem:** Çalışmaya ulusal düzeyde yarışan 81 erkek basketbolcu (yaş: 19.2 ± 1.2 yıl) katılmıştır. Sporcular oyun kurucu, şutör gard, kısa forvet, uzun forvet ve pivot olarak sınıflandırılmıştır. Ölçümler; boy uzunluğu, vücut ağırlığı, beden kütle indeksi, ekstremit segment uzunlukları, el kavrama kuvveti, 10 m ve 20 m sprint performansı, sıçrama performansı (dikey sıçrama [VJ] ve countermovement jump [CMJ]) ve esnekliği kapsamaktadır. Veriler tek yönlü varyans analizi (ANOVA), Tukey post-hoc testi ve Pearson korelasyon analizi ile değerlendirilmiştir. **Bulgular:** Pozisyonlara göre boy uzunluğu, vücut ağırlığı, beden kütle indeksi, ekstremit segment uzunlukları, esneklik, yaş ve 20 m sprint performansı açısından anlamlı farklılıklar bulunmuştur ($p<0.05$). Buna karşın el kavrama kuvveti, 10 m sprint performansı, dikey sıçrama (VJ) ve countermovement jump (CMJ) değerlerinde anlamlı farklılık saptanmamıştır ($p>0.05$). Pivot ve uzun forvet oyuncuların antropometrik değerleri diğer pozisyonlara göre daha yüksek bulunmuştur. El kavrama kuvveti ile el ve kol uzunluğu arasında orta düzeyde pozitif ilişki belirlenmiştir ($r=0.31-0.41$). **Sonuç:** Elit erkek basketbolcularda pozisyona özgü antropometrik özellikler belirgin olmakla birlikte, bazı performans değişkenlerinin daha çok bireysel özelliklerden etkilendiği görülmektedir. Bu bulgular, pozisyona özgü antrenman planlaması ve performans optimizasyonu açısından yol gösterici olabilir.

Anahtar Kelimeler: Basketbol, Antropometri, Oyun Pozisyonu, Fiziksel Uygunluk.

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Bu makaleye atf yapmak için / Cite this article: Güler Kanter, A., Gür, Y., & Karaoğlu, M. F. (2026). Positional differences in anthropometric and physical fitness characteristics among elite male basketball players. *BAUN Health Sci J*, 15(2), 266-273. <https://doi.org/10.53424/balikesirsbd.1863430>



BAUN Health Sci J, OPEN ACCESS <https://dergipark.org.tr/tr/pub/balikesirsbd>

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INTRODUCTION

Basketball requires integrating physical, technical, and perceptual–cognitive abilities under high temporal constraints. Players frequently perform short-distance accelerations, rapid directional changes, repeated jumps, and ball-handling tasks. Therefore, performance depends not only on tactical factors but also on anatomical and physiological characteristics (Ransone, 2016; Alemdaroğlu, 2012). At the elite level, each playing position is associated with distinct anthropometric features. Variables such as height, body mass, limb lengths, and hand size have been shown to influence basketball performance (Ziv & Lidor, 2009). Taller players with greater reach are generally more effective in rebounding, defense, and close-range scoring, highlighting the importance of body profiling in talent identification and position assignment (Canlı & Taşkın, 2024). Anthropometric assessments also support individualized training and help explain position-specific adaptations (Kostopoulos, 2015).

Physical fitness variables complement morphological characteristics in determining performance. Grip strength relates to ball control, sprint tests reflect acceleration capacity, flexibility indicates range of motion and jump tests such as the countermovement jump (CMJ) and vertical jump (VJ) assess lower-limb power (Markovic & Mikulic, 2004). Together, these variables provide a multidimensional perspective on basketball performance.

Although positional differences in anthropometric and physical fitness characteristics have been widely investigated, the existing literature presents several limitations. First, many studies have focused primarily on general anthropometric or performance variables without integrating detailed segmental measurements and upper-extremity characteristics such as hand dimensions and grip strength. Second, findings regarding the relationship between morphological characteristics and specific performance outcomes remain inconsistent, particularly when considering position-specific demands. In addition, relatively few studies have examined these variables within a single analytical framework that combines anthropometric profiling with multiple physical performance indicators.

Therefore, a more comprehensive evaluation integrating anthropometric characteristics, limb segment dimensions, and physical performance variables may provide additional insight into position-specific performance profiles. Such an approach may also contribute to more effective training prescription and talent identification strategies in elite basketball. In addition, previous studies have rarely examined upper-extremity anthropometric characteristics such as hand dimensions together with multiple field-based performance variables within a single cohort of elite players. Therefore, the present study aims to provide a more integrated perspective by combining detailed

segmental anthropometry with selected performance indicators in a unified analytical framework.

Accordingly, the aim of this study was to examine anthropometric and physical fitness differences among elite male basketball players according to playing position and to explore the relationships between selected anthropometric characteristics and performance variables. It was hypothesized that (i) anthropometric characteristics would differ across playing positions, and (ii) upper-extremity dimensions would be associated with handgrip strength.

MATERIALS AND METHODS

Study design and participants

This cross-sectional study examined positional differences in anthropometric and physical performance characteristics among elite male basketball players. Data were collected during the competitive season (September–November 2025) in Türkiye.

A total of 81 nationally competitive male basketball players who were actively training and competing were included in the final analyses. All participants held valid Turkish Basketball Federation licenses. Players who had sustained any musculoskeletal injury within the previous six months were excluded.

All athletes were engaged in regular training programs, typically involving approximately four training sessions per week, and had a minimum of three years of structured basketball training experience.

Participants were classified into playing positions (point guard, shooting guard, small forward, power forward, and center) based on official team rosters and confirmation from their coaches. Players with clearly defined primary positions were included in the final analysis. The distribution of players was as follows: point guards ($n=22$), shooting guards ($n=15$), small forwards ($n=30$), power forwards ($n=8$), and centers ($n=6$).

Variables

Playing position (point guard, shooting guard, small forward, power forward, and center) was defined as the main independent variable. Anthropometric measures included height, body mass, body mass index (BMI), and limb segment lengths (arm, leg, and hand). Physical fitness variables comprised handgrip strength, 10 m and 20 m sprint performance, vertical jump (VJ), countermovement jump (CMJ), and flexibility.

Procedures

All measurements were conducted in the morning under standardized indoor conditions to minimize environmental variability. Prior to testing, participants completed a standardized warm-up consisting of low-intensity running, dynamic stretching, and mobility exercises commonly used in basketball practice. The warm-up lasted approximately 10 minutes.

All tests were administered in a fixed order (anthropometric measurements, sprint tests, jump tests, and handgrip strength) to ensure consistency across participants. Adequate rest intervals (approximately 1–2 minutes) were provided between trials and tests to minimize fatigue effects.

Anthropometric measurements were obtained by the same trained investigator in accordance with the guidelines of the International Society for the Advancement of Kinanthropometry (ISAK). Body height and body mass were measured using calibrated equipment, and limb segment lengths (arm, leg, and hand) were assessed using standard anthropometric techniques.

Handgrip strength was measured using a digital hand dynamometer (TUORE, China). Participants performed the test in a standing position with the arm extended alongside the body. Three maximal trials were performed, and the highest value was recorded for analysis. Measurements were obtained from the dominant hand.

Sprint performance over 10 m and 20 m distances was assessed using an electronic timing gate system (SmartSpeed, Fusion Sport, Australia). Participants performed maximal-effort sprints from a standing start position. Each participant performed two to three trials, and the best performance was recorded.

Vertical jump (VJ) and countermovement jump (CMJ) performances were measured using a digital jump measurement system under standardized testing protocols commonly used in basketball performance assessment. Participants performed maximal jumps using proper technique. Each participant performed two to three trials, and the best performance was recorded.

Flexibility was assessed using the sit-and-reach test following standard procedures. Each participant performed two trials, and the best score was recorded.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics (Version 25.0; IBM Corp., Armonk, NY, USA). Descriptive statistics were calculated for all variables. The normality of the data distribution was assessed using the Shapiro–Wilk test, and homogeneity of variances was evaluated using Levene's test. One-way analysis of variance (ANOVA) was used to compare variables across playing positions. When significant differences were detected, Tukey's post hoc test was applied. Pearson correlation analysis was conducted to examine relationships between anthropometric variables and performance outcomes.

Statistical significance was set at $p < 0.05$.

Ethical consideration

Participation was voluntary, and written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of [Kilis 7 Aralık University] (Approval No: 2025/11, Date: 20/06/2025).

RESULTS

The descriptive characteristics of the participants are presented in Table 1. The players had a mean age of 19.2 ± 1.2 years, a mean height of 180.1 ± 8.3 cm, and a mean body mass of 70.9 ± 15.2 kg. The mean handgrip strength was 36.4 ± 6.5 kg, and average sprint times were 2.06 ± 0.25 s for 10 m and 3.49 ± 0.32 s for 20 m. Mean jump performances were 37.2 ± 9.8 cm for vertical jump (VJ) and 36.5 ± 7.7 cm for countermovement jump (CMJ). Table 2 presents anthropometric and physical performance variables by playing position.

Table 1. Descriptive characteristics of the participants (n = 81).

Variable	Mean $\pm$ SD
Height (cm)	180.1 $\pm$ 8.3
Body mass (kg)	70.9 $\pm$ 15.2
BMI (kg/m ²)	21.8 $\pm$ 3.6
Age (years)	19.2 $\pm$ 1.2
Arm length (cm)	80.3 $\pm$ 5.0
Leg length (cm)	92.5 $\pm$ 5.4
Hand length (cm)	21.6 $\pm$ 1.3
Handgrip strength (kg)	36.4 $\pm$ 6.5
Sprint 10 m (s)	2.06 $\pm$ 0.25
Sprint 20 m (s)	3.49 $\pm$ 0.32
Flexibility (cm)	29.4 $\pm$ 7.9
Vertical jump (VJ, cm)	37.2 $\pm$ 9.8
Countermovement jump (CMJ, cm)	36.5 $\pm$ 7.7

Data are presented as mean $\pm$ standard deviation. Abbreviations: VJ = Vertical Jump; CMJ = Countermovement Jump.

Positional differences in anthropometric and performance parameters

One-way ANOVA results (Table 4) revealed statistically significant differences between playing positions in height, body mass, BMI, arm length, leg length, hand length, sprint 20 m performance, flexibility, and age ($p < 0.05$). Effect size analysis (η^2) indicated that the largest positional differences were observed for height, body mass, and leg length, suggesting substantial practical differences between playing positions. Arm length and hand length also showed meaningful effect sizes, whereas sprint 20 m performance, flexibility, BMI, and age demonstrated comparatively smaller effects.

No statistically significant differences were observed for handgrip strength, 10 m sprint performance, vertical jump (VJ), or countermovement jump (CMJ) ($p > 0.05$). Post-hoc analyses (Table 3) indicated that centers were significantly taller and heavier than point guards, shooting guards, and small forwards ($p < 0.05$). In addition, hand length was significantly greater in power forwards and centers compared to point guards ($p < 0.05$).

Graphical representation of the results

Figures 1–6 illustrate the distribution of key anthropometric and performance variables across playing positions. Consistent with the statistical

findings, centers and power forwards tended to exhibit higher anthropometric values, whereas

differences in sprint and jump performance were less pronounced, except for 20 m sprint performance.

Table 2. Anthropometric and physical fitness variables by playing position.

Variable	PG (n=22)	SG (n=15)	SF (n=30)	PF (n=8)	C (n=6)
BMI (kg/m ²)	21.2±2.4	21.3±2.5	21.4±3.5	22.4±4.6	26.3±4.4
Leg length (cm)	88.0±4.5	91.0±5.0	92.5±4.2	96.8±3.6	98.7±6.2
Height (cm)	171.0±7.5	179.5±4.8	181.5±6.9	187.5±2.8	193.0±5.9
Countermovement jump (CMJ, cm)	37.0±6.2	33.5±3.1	35.5±5.0	36.0±7.2	33.0±8.4
Handgrip strength (kg)	36.0±5.2	35.2±6.5	33.5±6.4	37.4±6.3	30.5±1.5
Hand length (cm)	20.8±1.2	20.9±1.1	21.4±1.4	22.5±1.0	22.4±1.6
Flexibility (cm)	31.5±8.3	25.0±6.2	28.5±7.2	30.5±6.1	19.8±6.2
Body mass (kg)	61.0±8.0	69.0±10.5	71.0±13.8	78.0±17.0	97.5±14.0
Arm length (cm)	76.5±4.0	77.8±2.1	80.0±5.4	83.5±2.3	84.1±3.5
Sprint 10 m (s)	1.98±0.20	2.02±0.15	2.20±0.25	2.12±0.24	2.26±0.23
Sprint 20 m (s)	3.44±0.28	3.52±0.20	3.56±0.18	3.58±0.28	3.86±0.23
Vertical jump (VJ, cm)	38.0±6.5	35.0±4.3	33.0±5.6	35.8±5.5	28.5±7.3
Age (years)	18.6±0.9	19.2±1.1	18.9±1.1	19.5±1.0	21.2±1.6

Data are presented as mean ± standard deviation. Group differences were analyzed using one-way ANOVA.

Abbreviations: PG = Point Guard, SG = Shooting Guard, SF = Small Forward, PF = Power Forward, C = Center.

Table 3. Tukey post-hoc comparisons (only statistically significant differences).

Variable	Comparison	Mean difference	p	Significance
Height (cm)	PG vs C	-22.24	< 0.01	***
	SG vs C	-13.57	< 0.01	***
	SF vs C	-11.75	< 0.01	***
	PG vs PF	-16.57	< 0.01	***
	SG vs PF	-7.90	0.02	*
	PG vs SF	-10.49	< 0.01	***
	PG vs SG	-8.67	< 0.01	***
Body mass (kg)	PG vs C	-36.54	< 0.01	***
	SG vs C	-28.60	< 0.01	***
	SF vs C	-27.31	< 0.01	***
	PF vs C	-19.66	0.04	*
	PG vs PF	-16.88	0.02	*
Hand Length (cm)	PG vs PF	-1.74	0.03	*
	PG vs C	-1.67	0.03	*

p-values are based on Tukey HSD post-hoc tests following one-way ANOVA. Statistical significance was set at $p < 0.05$. Significance codes: * $p < 0.05$ (*), ** $p < 0.01$ (**), *** $p < 0.001$ (***).

Table 4. One-way ANOVA results with effect sizes by playing position.

Variable	F	p	η^2
Height (cm)	23.68	<0.001*	0.55
Body mass (kg)	9.73	<0.001*	0.34
BMI (kg/m ²)	2.69	0.021*	0.12
Arm length (cm)	6.28	<0.001*	0.25
Leg length (cm)	10.90	<0.001*	0.36
Hand length (cm)	5.09	0.002*	0.21
Sprint 20 m (s)	3.72	0.007*	0.16
Flexibility (cm)	2.85	0.025*	0.13
Age (years)	4.92	<0.001*	0.21

p-values were obtained using one-way ANOVA. Statistical significance was set at $p < 0.05$. Significant values are indicated with an asterisk (*). Eta squared (η^2) values are reported to aid interpretation of the practical significance of positional differences.

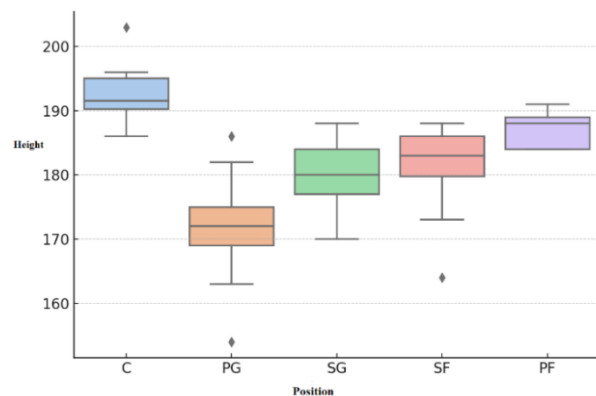


Figure 1. Boxplot showing the distribution of height among basketball players by playing position.

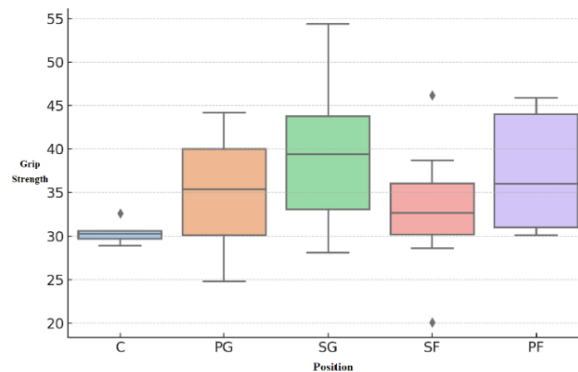


Figure 3. Boxplot showing handgrip strength across playing positions.

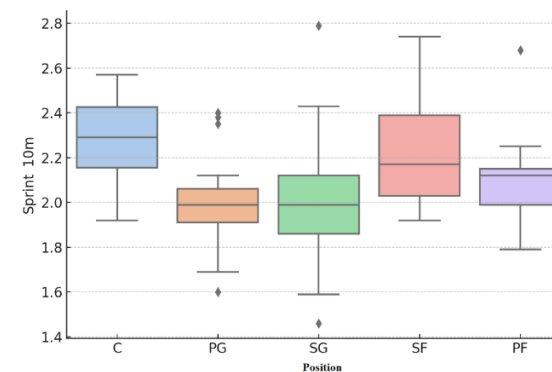


Figure 5. Boxplot illustrating 10-meter sprint performance across playing positions.

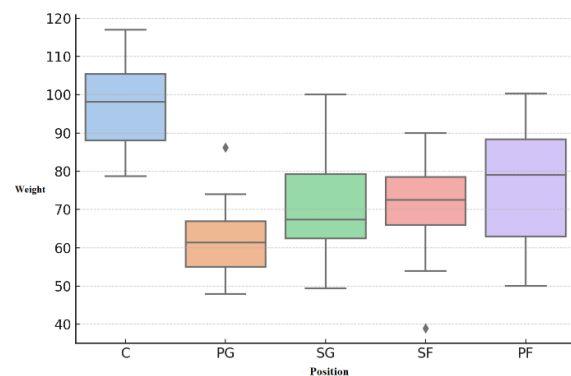


Figure 2. Boxplot showing the distribution of body mass among basketball players by playing position.

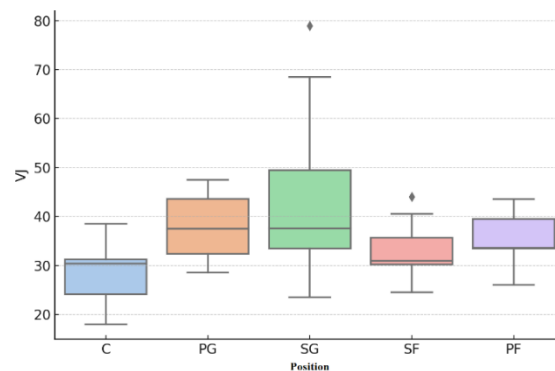


Figure 4. Boxplot illustrating vertical jump (VJ) performance across playing positions.

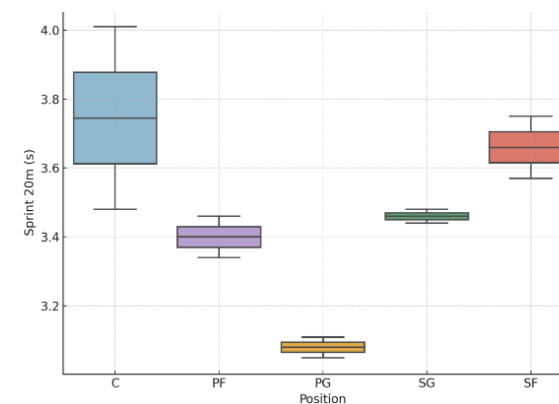


Figure 6. Boxplot showing 20-meter sprint performance across playing positions.

DISCUSSION

This study examined positional differences in anthropometric and physical performance characteristics in elite male basketball players and explored the relationships between selected anthropometric variables and performance outcomes. Moderate associations were observed between hand and arm dimensions and grip strength, supporting previous evidence that upper-limb morphology contributes to grip performance (Visnapuu & Jürimäe, 2007; Ruiz et al., 2006; Hoare, 2000). These findings are also consistent with recent research emphasizing the role of morphological characteristics in sport-specific performance capacities (Čović et al., 2023).

Significant positional differences in height and body mass were observed, with centers and power forwards showing the highest values and point guards the lowest. These findings are in line with previous studies reporting that anthropometric characteristics vary systematically across playing positions in basketball (Gryko et al., 2018; Cui et al., 2019). Similarly, a recent systematic review by Han et al. (2023) highlighted that body size and limb length are among the key determinants for positional specialization and talent identification in basketball. The present results may further support the importance of anthropometric profiling in understanding position-specific demands.

Beyond statistical significance, effect size analysis offers important insight into the practical relevance of these findings. The largest effect sizes were observed for height, body mass, and leg length, indicating that positional differences in these anthropometric variables are not only statistically significant but also practically meaningful. Arm length and hand length also contributed meaningfully to positional differentiation, whereas sprint 20 m performance, flexibility, BMI, and age showed comparatively smaller effect sizes. This distinction underscores the importance of considering both statistical significance and effect size when interpreting position-specific performance characteristics.

Sprint performance results indicated that sprint 20 m performance differed significantly between positions, suggesting that speed over longer short-distance intervals may vary according to positional roles. This finding is partially consistent with previous literature indicating that backcourt players tend to demonstrate higher speed and acceleration capacities due to tactical demands such as ball handling and rapid transitions (Morrison et al., 2022). However, the absence of significant differences in 10 m sprint performance may suggest that short-distance acceleration is not strongly influenced by playing position in this sample.

In contrast, frontcourt players tended to have greater body mass and longer limbs, which may indicate a need for training strategies focused on maximal

strength, trunk stability, and contact tolerance. These characteristics may align with the physical demands of rebounding, screening, and close-range scoring, where body size and strength are critical (Cui et al., 2019; Han et al., 2023). However, maintaining adequate mobility and movement efficiency remains essential for these players despite their larger body mass.

No significant positional differences were found in countermovement jump (CMJ) performance, which may suggest that CMJ reflects individual neuromuscular characteristics rather than strictly positional demands. This finding is partially consistent with previous research showing that jump performance may not always clearly differentiate playing positions (Pehar et al., 2017).

Similarly, no significant differences in vertical jump (VJ) performance were observed, suggesting that jump performance may not be strongly influenced by positional role in this sample.

No significant differences in handgrip strength were observed, suggesting that grip strength is more closely related to individual morphological characteristics than to positional roles.

Overall, the findings suggest that elite basketball players may exhibit position-specific anthropometric profiles, while some performance variables appear to be influenced more by individual characteristics than by positional roles. Integrating these characteristics into training design may enhance performance optimization and support individualized conditioning strategies.

This study has several limitations that should be considered when interpreting the findings. First, the positional subgroups were unequal in size, particularly for power forwards and centers, which may have reduced the statistical stability of between-group comparisons. Second, no a priori sample size calculation was performed, and therefore the statistical power for some positional comparisons may have been limited. Third, the cross-sectional design of the study does not allow for causal inferences regarding the relationships between anthropometric characteristics and performance variables. In addition, the sample consisted exclusively of elite male basketball players from Türkiye, which may limit the generalizability of the findings to female athletes, younger age groups, or players from different competitive levels and cultural contexts. Furthermore, although field-based performance tests were selected due to their practical relevance, more detailed laboratory-based assessments (e.g., biomechanical or neuromuscular analyses) could provide deeper insight into position-specific performance characteristics. Future research involving larger and more balanced samples, as well as more comprehensive performance testing protocols, is recommended to further clarify these relationships.

CONCLUSION

Elite male basketball players exhibit position-specific anthropometric and physical fitness profiles, reflecting the multidimensional nature of basketball performance. Frontcourt players tended to be characterized by greater body size and limb dimensions.

Sprint 20 m performance differed significantly between positions, indicating potential differences in speed-related performance across playing roles, whereas no significant positional differences were observed in short-distance sprint (10 m), handgrip strength, or jump performance.

From a practical perspective, these findings support the importance of position-specific profiling and individualized training strategies in elite basketball. Coaches and practitioners may benefit from tailoring training programs according to positional demands while considering individual variability in performance capacities. Future research with larger and more diverse samples is needed to further clarify position-specific performance characteristics.

Acknowledgement

The authors would like to extend their sincere thanks to anyone who contributed to this study.

Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Author Contributions

Plan, design: AGK; **Material, methods and data collection:** YG, MFK; **Data analysis and comments:** YG, MFK; **Writing and corrections:** AGK.

Funding

None.

Ethical Approval

Institution: Kilis 7 Aralık University Ethics Committee

Date: 20.06.2025

Approval no: 2025/11

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