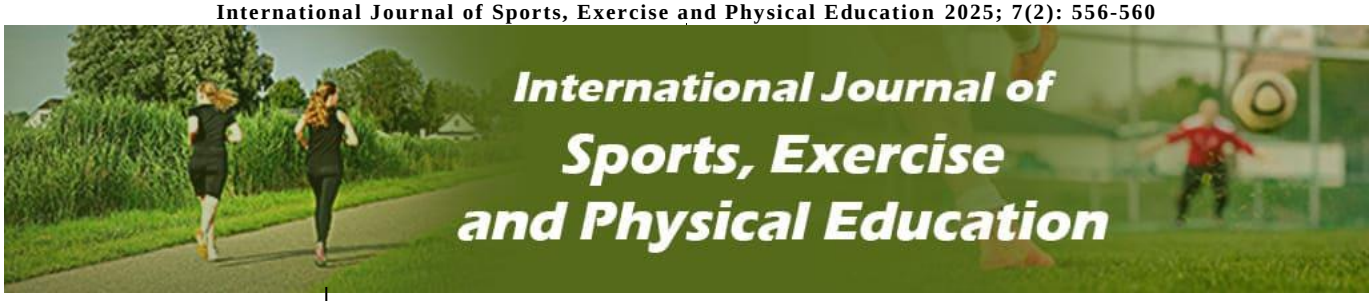

ISSN Print: 2664-7281
ISSN Online: 2664-729X
Impact Factor: RJIF 8.15
IJSEPE 2025; 7(2): 556-560
www.sportsjournals.net
Received: 12-09-2025
Accepted: 09-10-2025

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Positional differences in anthropometric characteristics of Indian national-level basketball players

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DOI: https://www.doi.org/10.33545/26647281.2025.v7.i2h.272

Abstract
Research Purpose: This study aimed to identify and interpret the key anthropometric determinants that distinguish national-level Indian basketball players across three positional roles Point Guards (PG), Shooting Guards (SG), and Centers (C). The research sought to establish how specific physical attributes contribute to positional specialization and can serve as objective indicators for talent identification and player classification in elite basketball.
Materials and Methods: A descriptive cross-sectional design was implemented with 60 male national-level basketball players (20 per position), aged 20-25 years. Anthropometric measurements height, arm span, leg length, and palm span were collected following standardized protocols using a stadiometer and flexible measuring tape. Each measurement was recorded twice, and mean values were used for accuracy. Statistical analyses included One-Way ANOVA and Welch's test ($p<0.05$), performed using IBM SPSS 26.
Results: The analysis revealed significant positional variations in height ($F=20.72$, $p<.001$), arm span ($F=5.60$, $P=.006$), and leg length ($F=6.86$, $P=.002$), while palm span showed no significant differences ($p>.05$). Centers demonstrated superior body dimensions overall, while guards presented compact morphologies suited for agility and speed. The span-to-height ratio (106%) reflected an extended reach advantage typical of elite basketball players.
Conclusion: The study establishes that specific anthropometric traits act as discriminating indicators among positional roles, highlighting height, arm span, and leg length as the most influential variables in determining positional suitability. These findings extend prior descriptive work by providing an interpretive basis for data-driven talent identification and role allocation within Indian basketball. Future research should integrate biomotor and skill-related parameters to construct comprehensive player classification models.

Keywords: Anthropometry, morphological differentiation, player classification, positional specialization, basketball

Introduction
Basketball is a multi-dimensional, position-specific sport wherein physical, morphological, and technical attributes interact dynamically to shape performance (Čović *et al*., 2023) [4]. In recent years, basketball has exhibited a marked rise in its physical demands, driven by modifications in game rules and the continual evolution of tactical strategies (Abdelkrim *et al*., N.D.) [1]. At the elite level, coaches and selectors often rely on anthropometric traits such as height, limb length, and reach as foundational criteria for role allocation (Alejandro *et al*., 2015) [2]. These structural traits provide a "morphological envelope" within which functional performance and skill execution must operate.
In basketball, different positions (e.g. point guard, shooting guard, center) impose distinct demands: guards need agility, speed, and ball-handling in open space; centers require reach, rebound power, and interior presence. Based on their specific playing positions such as guard, forward, or center basketball players exhibit distinct skill requirements and physiological demands. Each position necessitates the development of specialized attributes that correspond to its tactical and physical responsibilities on the court (Cengizel & Cengizel, 2022) [3]. Considering that basketball players perform distinct functional roles on the court, it becomes essential to examine their anthropometric and physical profiles according to their specific playing positions (Nikolaidis *et al*., 2014) [9].

This divergence suggests that anthropometric differentiation the measurable morphological differences among positions should be systematically quantifiable. For example, (Gryko *et al*., 2018) [7] found that centers in both youth and adult male elites are significantly taller and heavier than guards or forwards, and that arm span was among discriminating features for center allocation.

Similarly, comprehensive meta-analyses in basketball talent identification have confirmed that height, body mass, agility, jump performance, and speed repeatedly emerge as key discriminators of elite versus sub-elite or positional groups (Han *et al*., 2023) [8]. These results validate the centrality of anthropometry integrated with performance metrics in selection models.

Despite numerous international investigations, anthropometric studies in the Indian basketball context remain scant. Most published Indian studies focus broadly on profiling physical traits of regional or inter-university samples (e.g. anthropometric & physiological characteristics of Indian inter-university basketball players) (Dr. Koley Shyamal, 2010) [6]. Rather than explicitly analysing positional differentiation using selectively measurable traits. In addition, many profiling studies include dozens of anthropometric, physiological, and performance variables, which makes the translation of findings into practical selection metrics difficult. Another gap is in analytical framing: many studies proceed as descriptive "profiles" (e.g., mean values per position) rather than hypothesis-driven comparisons (e.g., "which anthropometric traits differ significantly by position?"). For instance, (Puranik *et al*., 2019) [10] conducted an aggregated approach in Karnataka basketballers to examine anthropometric and physiological differences across positions but still framed it largely as normative profiling rather than targeted positional discrimination (Puranik *et al*., 2019) [10] In order to make the findings more actionable for coaches and talent identifiers, we need a leaner, comparative approach using a few key anthropometric variables to directly test positional differences. As performance demands differ across positions (guards rely more on speed/ball control; centers on reach/strength), task constraints interact with organismic constraints to favor players whose morphology aligns better with those demands. For example, a center with longer limbs and greater stature is better equipped to contend in the paint, whereas a guard with compact proportions may exploit agility. Integration of constraints theory thus offers a coherent rationale for why anthropometric differences should systematically vary by positional role, and supports framing our study as more than descriptive characterization.

The present study aims to examine positional differences in selected anthropometric traits among Indian national-level male basketball players, focusing on four accessible variables: height, arm span, leg length, and palm span.

Methodology

A total of sixty (N=60) male basketball players participated in the present study, with twenty athletes representing each playing position, Point Guards (PG), Shooting Guards (SG), and Centers (C). All players were national-level competitors, actively engaged in recognized professional and inter-state tournaments across India. Participants' ages ranged between 20 and 25 years, representing a physically matured cohort within their performance peak. The measurement was taken in players training facility where players stayed for practice. Selection was based on players' self-reported primary positions, verified by their respective team coaches, ensuring accurate positional classification for comparative analysis. Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was secured from all participants. Inclusion criteria required at least five years of continuous competitive experience and full physical fitness at the time of measurement. Players with any recent injuries or functional limitations were excluded. Data were anonymized, entered into Excel, cross-verified, and imported to SPSS 26 for analysis.

- **Study Design:** The investigation adopted a quantitative, descriptive comparative, cross-sectional design, aimed at identifying positional differences in anthropometric characteristics among elite male basketball players. The study specifically assessed height, arm span, leg length, and palm span as the primary morphological indicators. This approach was chosen to provide a comparative understanding of how structural traits differ across positional roles and to generate data useful for selection, training, and role assignment in high-performance basketball. The design aligns with the established methodology used in morphological profiling studies within sport science (Han *et al*., 2023; Čović *et al*., 2023) [8, 4].
- **Data Collection Procedures:** All measurements were conducted in a controlled environment to ensure uniform testing conditions and minimize measurement bias. Participants reported in light training attire, barefoot, and in a rested physiological state before testing.
- **Height (cm):** Measured using a calibrated *stadiometer and measuring tape* with the participant standing erect, heels together, and head positioned in the Frankfort plane.
- **Arm Span (cm):** Recorded using a flexible steel tape from the tip of one middle finger to the other with arms fully extended horizontally at shoulder level.
- **Leg Length (cm):** Measured from the anterior superior iliac spine to the medial malleolus using a flexible measuring tape.
- **Palm Span (cm):** Measured from the tip of the thumb to the tip of the little finger with the hand fully extended but not overstretched.

Each measurement was taken twice, and the average value was recorded for analysis to reduce intra-tester error. The same trained investigator performed all tests, assisted by an experienced research scholar, following the measurement principles recommended by the International Society for the Advancement of Kinanthropometry.

Statistical Analysis

All recorded data were first tabulated using Microsoft Excel and then exported to IBM SPSS Statistics version 26 for further analysis. Descriptive statistics, including mean, standard deviation, and 95% confidence intervals, were calculated for all anthropometric variables across the three playing positions point guards (PG), shooting guards (SG), and centers (C) to establish positional profiles. Prior to inferential analysis, the Shapiro-Wilk test was employed to verify the normality of distribution, and Levene's test was used to assess the homogeneity of variances among the groups.

Table 1: Descriptive Statistics

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Height	Pointguard	20	175.4000	3.88519	.86876	173.5817	177.2183	169.00	182.00
	Shootingguard	20	182.2500	3.61102	.80745	180.5600	183.9400	169.00	185.00
	Center	20	187.3400	8.70640	1.94681	183.2653	191.4147	173.00	200.60
	Total	60	181.6633	7.60323	.98157	179.6992	183.6275	169.00	200.60
ARMSPAN	Pointguard	20	185.5000	8.98244	2.00853	181.2961	189.7039	172.00	203.00
	Shootingguard	20	189.9000	6.98984	1.56298	186.6287	193.1713	177.50	203.00
	Center	20	194.2500	8.69134	1.94344	190.1823	198.3177	182.00	210.00
	Total	60	189.8833	8.88932	1.14761	187.5870	192.1797	172.00	210.00
Leg length	Pointguard	20	97.0500	2.81864	.63027	95.7308	98.3692	90.00	102.00
	Shootingguard	20	99.9500	2.91051	.65081	98.5878	101.3122	93.00	104.00
	Center	20	102.2000	6.46936	1.44659	99.1722	105.2278	94.00	113.00
	Total	60	99.7333	4.82531	.62294	98.4868	100.9798	90.00	113.00
Palmspan	Pointguard	20	22.3000	1.75019	.39135	21.4809	23.1191	20.00	25.00
	Shootingguard	20	23.0500	1.66148	.37152	22.2724	23.8276	20.00	25.00
	Center	20	23.3750	1.44982	.32419	22.6965	24.0535	22.00	27.00
	Total	60	22.9083	1.66084	.21441	22.4793	23.3374	20.00	27.00

Based on the outcomes of these assumption checks, one-way analysis of variance (ANOVA) was applied to determine whether statistically significant differences existed in height, arm span, leg length, and palm span across the three positions. When the assumption of equal variances was met, Turkey's Honest Significant Difference (HSD) test was used for post-hoc pairwise comparisons. For variables violating homogeneity assumptions, a Welch ANOVA was conducted, followed by the Games-Howell post-hoc test, which provides more reliable results under unequal variance conditions. In addition to p-values, effect size (η^2) was computed for each ANOVA to quantify the magnitude of observed differences, with η^2 values interpreted as small (0.01), medium (0.06), or large (0.14) according to conventional thresholds. Statistical significance was set at $p<0.05$. The analytical framework was designed to identify and interpret meaningful positional variations in anthropometric traits, thereby providing applied insights for talent identification and player selection in competitive basketball.

Table 2: One way-ANOVA

		Sum of Squares	DF	Mean Square	F	Sig.
Height	Between Groups	1435.961	2	717.981	20.724	.000
	Within Groups	1974.778	57	34.645		
	Total	3410.739	59			
ARMSPAN	Between Groups	765.633	2	382.817	5.600	.006
	Within Groups	3896.550	57	68.361		
	Total	4662.183	59			
Leglength	Between Groups	266.633	2	133.317	6.864	.002
	Within Groups	1107.100	57	19.423		
	Total	1373.733	59			
Palmspan	Between Groups	12.158	2	6.079	2.301	.109
	Within Groups	150.587	57	2.642		
	Total	162.746	59			

Results

The present study aimed to analyse the anthropometric variations among national-level Indian basketball players across three positional roles Point Guard (PG), Shooting Guard (SG), and Center (C). Descriptive statistics and one-way ANOVA were employed to examine differences in four key morphological variables: height, arm span, leg length, and palm span.

Overall, the players demonstrated a mean height of 181.66±6.69 cm, placing the sample within the tall-stature category typical of elite-level basketball athletes. A right-skewed distribution suggested the inclusion of exceptionally tall individuals, primarily centers. The mean arm span (192.55±8.93 cm) exceeded height by approximately 11 cm, reflecting the characteristic morphological advantage observed among basketball players, which facilitates rebounding, defensive coverage, and passing.

Leg length averaged 100.91±5.19 cm, with moderate variability, indicating positional differences in lower limb dimensions that influence stride efficiency and jump reach. The mean palm span (22.89±1.70 cm) displayed minimal variation, implying relatively uniform hand dimensions across positions. The Span-Height ratio averaged 106.24%, confirming that players generally possessed arm spans longer than their height a typical trait among high-level basketball athletes.

Positional Comparisons (One-Way ANOVA Results)

The one-way ANOVA revealed significant positional differences for three of the measured variables Height ($F(2,57)=20.72$, $p<.001$, $\eta^2=0.42$), Arm Span ($F(2,57)=5.60$, $p=.006$, $\eta^2=0.16$), and Leg Length ($F(2,57)=6.86$, $p=.002$, $\eta^2=0.19$) while Palm Span did not differ significantly among positions ($F(2,57)=2.30$, $p=.109$, $\eta^2=0.07$).

Discussion of findings

The present study examined position-specific anthropometric characteristics among national-level Indian

male basketball players across three roles: Point Guards (PG), Shooting Guards (SG), and Centers (C). Utilizing descriptive statistics and one-way ANOVA, the study found that Centers showed significantly greater height, arm span, and leg length compared to guards, indicating morphological differentiation aligned with positional demands.

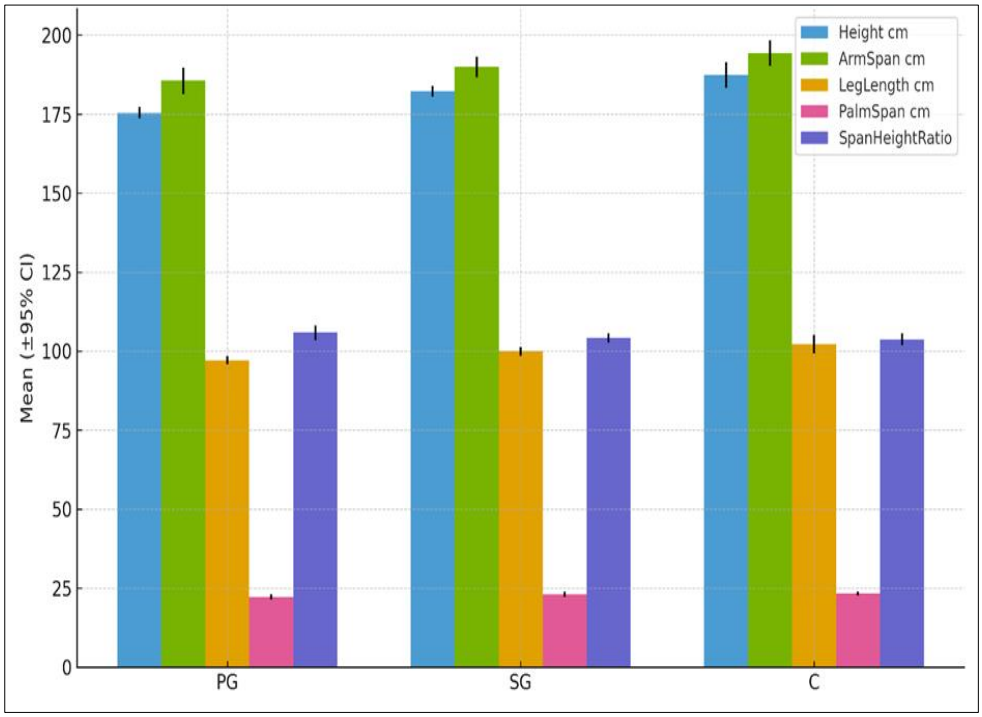

Fig 1: Anthropometric characteristics by playing position

Height, often regarded as a central determinant of performance in basketball, exhibited a strong positional variance ($F=20.72$, $p<.001$, $\eta^2=0.42$). This finding echoes the work of Drinkwater, which highlighted that larger body size confers tactical advantages in basketball. In the current dataset, Centers' average height and physical build support their role in rebounding, shot-blocking, and interior play, whereas guards manifested comparatively shorter stature suitable for speed and perimeter actions.

Leg length, another variable where significant differences were found ($F=6.86$, $p=.002$, $\eta^2=0.19$), underscores the importance of lower-limb morphology in sports such as basketball; longer limbs can enhance stride, jumping reach and paint area coverage. This manifests practically in the taller, longer-legged Centers, and more compact Guards whose morphology supports agility and quick directional changes.

Arm span also differentiated positions significantly ($F=5.60$, $p=.006$, $\eta^2=0.16$), with a significant difference between Centers and Point Guards. Although the span-to-height ratio did not differ significantly, the absolute wingspan advantage remains relevant. Supporting evidence from (Cui *et al*., 2019) showed that among high-level players, height and wingspan were key discriminators of future success.

Contrastingly, palm span did not differ significantly among positions ($F=2.30$, $p=.109$). While hand size can influence ball control and handling, the relative uniformity across roles in this elite Indian sample suggests it may be less decisive for positional specialization compared to body size and limb length.

These findings support the concept of morphological specialization in basketball that athletes' physical structures align with the demands of their roles on court. Coupled with the verified normative data in the literature (Sansone *et al*., 2022) [11], such anthropometric profiling offers practical value for talent identification and role assignment in Indian basketball teams.

Future research should integrate kinematic and performance metrics (e.g., vertical jump, sprint times, shooting accuracy) with anthropometric indicators to better understand how morphological traits translate to in-game effectiveness. Incorporating a larger and more diverse sample across regional academies could also enhance generalizability to the broader Indian basketball population.

Conclusion: The present study provides clear evidence of position-specific anthropometric differentiation among national-level Indian basketball players. Centers were significantly taller and possessed longer limbs than Guards, while Guards exhibited proportionally smaller builds suited for agility and perimeter play. These physical distinctions affirm that height, leg length, and arm span are the most critical anthropometric determinants of positional suitability in competitive basketball.

The findings emphasize the importance of morphological profiling for talent identification, player selection, and specialized training. Coaches and performance analysts can utilize these data as objective reference values to guide player development and optimize team composition. Although palm span did not significantly differ among positions, it remains a potential factor in handling and shooting performance.

Overall, this research contributes to the limited empirical literature on Indian basketball morphology, reinforcing the global evidence that physical structure underpins functional role specialization. Future investigations should integrate anthropometric, biomechanical, and performance variables to build predictive models of success, thereby bridging physical attributes with measurable on-court efficiency.

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