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Anthropometric characteristics and Somatotypes in Elite Pro Kabaddi League Players

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Resumen

Introducción: Los jugadores de Kabaddi exhiben diversas composiciones corporales que varían según la posición de juego. Comprender estos rasgos proporciona información valiosa sobre sus perfiles físicos y su potencial de rendimiento. El estudio tuvo como objetivo examinar las características antropométricas y los somatotipos de los jugadores profesionales de élite de Kabaddi indios y evaluar las diferencias en los rasgos antropométricos entre los defensores y los raiders. **Métodos:** Veinte jugadores de élite masculinos de Kabaddi (raiders n = 9 y defensores n = 11) parte del equipo de pretemporada de los Haryana Steelers durante la Temporada X, participaron en el estudio. Las mediciones antropométricas incluyeron masa corporal, estatura, 8 sitios de pliegues cutáneos, 3 perímetros y 2 anchos. Se calcularon los somatotipos, el porcentaje de grasa corporal, la masa grasa y la masa corporal magra para cada participante. Se utilizaron estadísticas descriptivas para estimar el estado funcional básico de los atletas. Se utilizó la prueba t de muestras independientes para probar las diferencias significativas entre los raiders y los defensores. **Resultados:** Se encontraron diferencias significativas entre los raiders y los defensores en siete de las treinta y seis variables. Los Raiders tuvieron valores medios más altos para la altura [t (18) = 2,71, p = 0,01], longitud de pierna [t (18) = 2,20, p = 0,04], relación altura-peso [t (18) = 2,79, p = 0,01] y componente ectomorfo [t (18) = 2,50, p = 0,02]. Por el contrario, los defensores tuvieron valores significativamente más altos para los pliegues cutáneos supraespinales [t (18) = -2,17, p = 0,04], la relación entre la extensión del brazo y la altura [t (18) = -2,53, p = 0,02] y el componente mesomorfo [t (18) = -2,33, p = 0,03]. Los intervalos de confianza del 95% para estas diferencias mostraron una variabilidad sustancial entre los parámetros examinados. **Conclusión:** El estudio revela diferencias antropométricas y somatotípicas entre los atacantes y los defensores en los jugadores de élite de Kabaddi indio, lo que enfatiza la necesidad de programas de entrenamiento específicos para cada posición. Estos hallazgos brindan información valiosa sobre los atributos físicos asociados con cada posición, lo que ayuda a los entrenadores a optimizar el desarrollo de los jugadores y la asignación de posiciones, al tiempo que enfatiza la importancia de la variabilidad individual en los programas de entrenamiento.

Palabras Clave: Antropometría, Somatotipo, Atletas indios, Kabaddi, Pliegues cutáneos

Abstract

Introduction: Kabaddi players exhibit diverse body compositions that vary by playing position. Understanding these traits provides valuable insights into their physical profiles and performance potential. The study aimed to examine the anthropometric characteristics and somatotypes of elite professional Indian Kabaddi players and to evaluate the differences in anthropometric traits between defenders and raiders. **Method:** Twenty male elite Kabaddi players (raiders n = 9, and defenders n = 11) part of the Haryana Steelers pre-season squad during Season-10, participated in the study. Anthropometric measurements included body mass, stature, 8 skinfold sites, 3 girths, and 2 breadths. Somatotypes, body fat percentage, fat mass, and lean body mass were calculated for each participant. Descriptive statistics were used to estimate the basic functional status of the athletes. Independent samples t test was used to test for significant differences between raiders and defenders. **Results:**

Significant differences were found between raiders and defenders across seven out of thirty-six variables. Raiders had higher mean values for height [t (18) = 2.71, p = 0.01], leg length [t (18) = 2.20, p = 0.04], height-weight ratio [t (18) = 2.79, p = 0.01], and ectomorph component [t (18) = 2.50, p = 0.02]. In contrast, defenders had significantly higher values for supraspinale skinfolds [t (18) = -2.17, p = 0.04], arm span to height ratio [t (18) = -2.53, p = 0.02], and mesomorph component [t (18) = -2.33, p = 0.03]. The 95% confidence intervals for these differences showed substantial variability across the examined parameters. **Conclusion:** The study reveals anthropometric and somatotype differences between raiders and defenders in elite Indian Kabaddi players, emphasizing the need for position-specific training programs. These findings provide valuable insights into the physical attributes associated with each position, aiding coaches in optimizing player development and positional assignment while emphasizing the importance of individual variability in training programs.

Keywords: Anthropometry, Somatotype, Indian athletes, Kabaddi, Skinfolds

Introduction

Kabaddi, is a traditional Indian sport deeply ingrained in the culture, and has garnered international recognition in recent years, particularly with the advent of professional leagues showcasing elite talent (Ali et al., 2011). Kabaddi players can be categorized into four groups based on their playing position: raiders, corners, covers, and all-rounders. The sport demands exceptional physical fitness, aerobic fitness, anaerobic fitness, agility, strength, neuromuscular coordination, lung capacity, quick reflexes, tactical awareness, and mental presence (Dey et al., 1993, Sathshivam et al., 2023). Kabaddi stands out as a complex technical endeavor, characterized by intricate gameplay dynamics. Moreover, differences in performance exist among players across varying levels of skill and ability (Roy et al., 2022). The modern sport of Kabaddi, distinguished by its high-intensity activities, imposes a diverse array of demands on players across all facets of their abilities. Virtually every skill and characteristic are called into action during a Kabaddi game, leaving no aspect of a player's capability unutilized (Devaraju & Needhiraja, 2013). Within Kabaddi, different positions execute distinct skills which demand a particular body somatotype and sport-specific talent. Anthropometric measurements help in performance prediction by identifying physical traits that correlate with success in specific sports, such as height and limb length in Kabaddi (Bangari & Haridas, 2021) or body composition in endurance sports (Knechtle, 2014). These metrics allow coaches to tailor training programs to enhance strengths and address weaknesses. Additionally, tracking these measurements over time can indicate potential for future development and performance improvements.

Thus, anthropometric measurements are essential to be carried out on individuals in an elite Kabaddi team, due to certain body types having an advantage over others. Major moves in the game of play in Kabaddi require players to jump, grab & hold, lock, twist and so on and such movements require the players to have an archetypal physiological and anthropometric characteristic (Dey et al., 1993). Kumar (2015) stated that kabaddi as a sport requires skills and power similar to Wrestling and Rugby, respectively. The ability to properly execute skills is interdependent on various parameters related to physiological, psychological, physical, technical, and tactical aspects (Francini et al., 2019). Identifying fat-mass and fat-free mass in terms of body composition is crucial as it translates to performance attributes since having excess fat can potentially slow a player down and hinder explosive movements. For instance, determining whether a player has more fat-mass for a certain weight will also assist the nutritionists and coaches to alter their diet and training to enhance performance where necessary (Slater & Phllips, 2013). A more muscular body composition can help with generation of more power and strength (Sathshivam et al., 2023). Anthropometric traits play a crucial role in Kabaddi as the sport involves physical contact, where individuals with specialized physiques with high levels of strength and power may have a competitive edge (Sidhu, 2018).

Sheldon (1940) introduced the three different categories of somatotypes and later Carter (2002) enumerated the terms, endomorphic (relative fatness), mesomorphic (relative musculoskeletal robustness) and ectomorphic (relative linearity or slenderness). Khanna et al. (1996) reported that elite Indian Kabaddi players have more endomorphic-mesomorphic body type. In recent years, a multitude of research investigations have delved into the correlations between anthropometric and physiological traits among kabaddi players (Majlesi et al., 2012; Patel et al., 2014). A detailed anthropometric analysis ultimately assists coaches in assigning the primary role in the game—like raiders or defenders—more effectively, ensuring that each player's physical characteristics are best suited to their position, thus improving overall team strategy and efficiency (Mahesh et al., 2022, Pandey & Sardar, 2016). Anthropometric profiles in elite Indian athletes across a range of combat sports have previously been established (Armendári et al. 2023). However, scientific research on the anthropometric profiles specific in elite Kabaddi players is limited, resulting in a lack of standardized data that could help optimize training regimens and talent identification processes.

The aim of this study is to establish the anthropometric somatotype of elite professional Indian Kabaddi players and to evaluate the differences in anthropometric traits between defenders and raiders.

Material and Methods

Subjects

Twenty male professional Kabaddi players of which 9 raiders and 11 defenders; (mean ± SD) age 22.65 ± 4.09 yrs, body mass 79.77 ± 6.86 kg, body stature 175.15 ± 6.18 cm, sitting height 90.83 ± 2.72 cm, leg length 84.32 ± 5.09cm, arm span 181.59 ± 5.48 cm, and BMI 26.01 ± 1.88 kg/m², were recruited for this study. Only players who were part of the Haryana Steelers squad during Season-10 (2023-2024) of the Pro Kabaddi League (India), were eligible to take part in the study. Verbal explanation of the experimental procedure was provided; this included the aims of the study, the possible risks associated with participation and the experimental procedures. The study was part of the general pre-season sports science provision of the Haryana Steelers and all the procedures used were reviewed and approved by the local ethics committee (EC/IIS/2023/014) and conformed to the recommendations of the Declaration of Helsinki.

Anthropometric Measurements

The anthropometric measurements were conducted according to the methodology established by the International Society for the Advancement of Kinanthropometry (ISAK handbook 2019). The anthropometric variables measured in this study were body mass, stature, skinfold thickness at seven different places (biceps, triceps, subscapular, supraspinale, abdominal, front thigh, and medial calf), three girth measurements (upper arm flexed, upper arm relaxed, and medial calf), and two breadth measurements (humeral and femoral epicondyles). Using a calibrated weighing scale (Essae DS-215, Bangalore, India), body mass was measured to the nearest 0.1 kg and stature to the nearest 0.1 cm using a stadiometer (Holtain Ltd., Crymych, United Kingdom). The skinfold thickness was measured with a calibrated Holtain skinfold caliper (Holtain Ltd., Crymych, United Kingdom) and recorded to the nearest 0.2 mm at a constant pressure of 10 $g \cdot mm^{-1}$. Skinfolds were measured two times per site using a rotation technique, with a third measurement made if necessary. The estimation of body fat percentage was conducted using the standard equation proposed by Faulkner in 1966. Girths were measured with precision to the nearest 0.1 cm using a flexible anthropometric tape (Anthroflex, Minneapolis, USA). The measurements were performed by certified ISAK L1 (RA) and ISAK L2 (SP) practitioners who have extensive expertise in conducting measurements.

Skinfolds

Sum of 4 Skinfolds = triceps + subscapular + supraspinale + abdominal

Sum of 6 Skinfolds = triceps + subscapular + supraspinale + abdominal + front thigh + medial calf

Sum of 8 Skinfolds = biceps + triceps + subscapular + iliac crest + supraspinale + abdominal + front thigh + medial calf

Body Fat Percentage (Faulkner Equation)

Body Fat (%) = 0.153 (Sum of 4 Skinfolds) + 5.783

Fat Mass (kg) = (Body Fat/100) X Body Weight

Lean Body Mass (kg) = Body Weight – Fat Mass

Somatotype

The Heath-Carter [1967] method was followed for somatotype rating. The following equations were used for calculating somatotype components.

Endomorphy = ─ 0.7182 + 0.1451 × ∑SF ─ 0.00068 × $\sum SF^2$+ 0.0000014 × $\sum SF^3$

where ∑SF = (sum of Triceps, Subscapular and Supraspinale skinfold) multiplied by (170.18/Height in cm).

Mesomorphy = 0.858 × Humerus breadth + 0.601 × Femur breadth + 0.188 × corrected Arm girth + 0.161 × corrected Calf girth ─ Height × 0.131 +4.5

Three different equations are used to calculate Ectomorphy according to the height -weight ratio (HWR):

1) If HWR is greater than or equal to 40.75 then, Ectomorphy = 0.732 × HWR ─ 28.58

2) If HWR is less than 40.75 and greater than 38.25 then, Ectomorphy = 0.463 × HWR ─ 17.63

3) If HWR is equal to or less than 38.25 then, Ectomorphy = 0.1

X-Coordinate = Ectomorphy - Endomorphy

Y-Coordinate = 2 x Mesomorphy – (Endomorphy + Ectomorphy)

Statistical Analysis

Data are presented as the mean ± SD and the Statistical Package for the Social Sciences (SPSS), version 28, for Windows were used. Descriptive statistics were used to estimate the basic functional status of the athletes with the mean, SD, and range (minimum and maximum values) calculated for measured parameters. Independent samples t test was used to compare the means of two independent groups (raiders and defenders) to determine if there is a significant difference between the variables selected. Assumptions of t-test, including normality and homogeneity of variances, were checked, and met. The level of significance was set to $p \leq 0.05$.

Results

Table 1 presents the descriptive statistics of basic measurements (age, height, weight, BMI), anthropometric measurements (skinfolds, girths, breadths, corrected girths, ratios, sum of skinfolds), somatotype body components (endomorph, mesomorph, ectomorph; Figure 1), percent body fat, fat-mass, and lean body mass among raiders and defenders.

Table 1. Proportionality and kinanthropometric descriptive characteristics of raiders and defenders.

Parameters	Raiders (n = 9)		Defenders (n = 11)	
	M (SD)	Range	M (SD)	Range
Basic Measurements				
Age (Years)	24.00 (5.48)	19.00 - 32.00	21.55 (2.21)	19.00 – 25.00
Height (cm)	178.73 (6.14)	172.40 – 192.00	172.22 (4.64)	166.20 – 182.40
Weight (kg)	80.44 (8.86)	65.90 – 95.10	79.22 (5.10)	71.30 – 90.50
Sitting-Height (cm)	91.89 (3.01)	87.40 - 96.10	89.96 (2.24)	86.40 – 93.10
Arm Span (cm)	183.43 (5.87)	173.30 – 194.30	180.08 (4.89)	172.80 – 188.30
Leg Length (cm)	86.84 (4.70)	80.40 – 95.90	82.25 (4.59)	76.80 – 93.80
BMI (kg/m^2)	25.14 (1.96)	21.03 – 27.61	26.72 (1.55)	23.50 – 29.08
Skinfold Thickness (mm)				
Triceps	7.22 (3.03)	4.15 – 13.90	7.45 (2.52)	4.05 – 13.20
Subscapular	11.18 (3.81)	7.05 – 17.10	12.05 (2.60)	7.00 – 15.30
Biceps	3.57 (0.77)	2.60 – 4.60	4.01 (0.83)	3.00 – 5.10
Iliac Crest	11.77 (5.34)	5.00 – 19.10	12.58 (3.32)	6.90 – 17.90
Supraspinale	6.92 (1.50)	4.80 – 9.30	8.86 (2.32)	5.70 – 13.10
Abdominal	15.78 (6.65)	5.80 – 27.30	17.14 (5.76)	9.70 – 27.10
Front Thigh	10.14 (4.17)	5.50 – 16.80	10.57 (3.97)	5.90 – 16.30
Calf	5.61 (1.21)	4.10 – 7.30	6.96 (2.01)	4.70 – 10.10
Girths (cm)				
Arm - Relaxed	33.66 (1.89)	31.10 – 37.30	33.69 (1.60)	31.30 – 36.00

Arm - Flexed	35.89 (1.67)	33.50 – 38.70	35.96 (1.37)	34.00 – 38.60
Waist	81.11 (4.06)	73.90 – 85.20	82.75 (4.29)	77.20 – 89.80
Hip	102.03 (7.18)	88.00 – 115.10	101.70 (2.93)	97.90 – 108.20
Calf	38.34 (2.39)	34.10 – 41.90	38.88 (1.72)	36.30 – 41.80
Breadths (cm)				
Humerus Breadth	6.97 (0.36)	6.50 – 7.50	6.84 (0.36)	6.20 – 7.30
Femur Breadth	9.89 (0.37)	9.30 – 10.30	10.01 (0.34)	9.60 – 10.50
Corrected Girths (cm)				
Corrected Arm	35.17 (1.72)	33.07 – 38.29	35.22 (1.37)	33.23 – 37.99
Corrected Calf	37.78 (2.39)	33.62 – 41.49	38.19 (1.68)	35.71 – 41.26
Ratios				
Waist-Hip	0.80 (0.03)	0.74 – 0.84	0.81 (0.04)	0.75 – 0.90
HWR	41.47 (1.17)	40.38 – 43.82	40.12 (0.99)	38.90 – 42.65
Arm Span to Height	1.03 (0.02)	1.01 – 1.05	1.05 (0.02)	1.02 – 1.07
Somatotype Components				
Endomorph	2.38 (0.85)	1.22 – 3.95	2.83 (0.65)	1.81 – 3.95
Mesomorph	5.70 (0.62)	4.87 – 6.67	6.59 (0.99)	4.26 – 7.93
Ectomorph	1.80 (0.84)	1.07 – 3.50	0.99 (0.60)	0.38 – 2.64
Sum of Skinfolds (mm)				
Sum of 4 Skinfolds	41.09 (14.26)	22.00 – 67.60	45.50 (10.49)	30.50 – 61.80
Sum of 6 Skinfolds	56.84 (18.73)	32.30 – 90.00	63.04 (14.69)	43.20 – 85.40
Sum of 8 Skinfolds	72.18 (23.59)	40.10 – 112.30	79.63 (17.98)	55.10 – 108.20
Body Fat (%)	16.65 (3.04)	12.59 – 22.30	17.59 (2.23)	14.40 – 21.06
Fat Mass (kg)	13.48 (3.19)	8.29 – 18.11	13.94 (1.95)	11.26 – 16.37
Lean Body Mass (kg)	66.97 (7.06)	57.61 – 78.13	65.28 (4.58)	58.21 – 74.73

Note: M = Mean; SD = Standard Deviation; HWR = Height Weight Ratio (cm/kg$^{1/3}$)

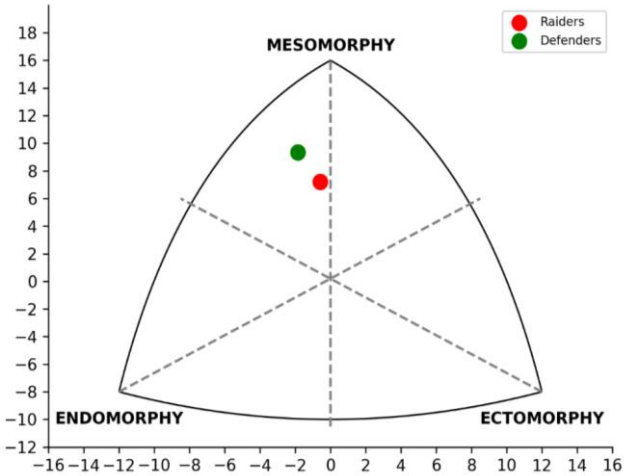

Figure 1. Somatoplot comparing raiders and defenders.

An independent samples t-test was conducted to compare the mean scores of the selected variables for the two groups. Comparing the results of raiders and defenders (Table 2) yielded by the t-test, the two groups proved to differ significantly ($p<0.05$) in 7 out of 36 variables: height, leg length, supraspinale skinfolds, height-weight Ratio, arm span to height ratio, mesomorphy and ectomorphy components.

Table 2. Independent Samples t-Test Comparing Means of Raiders and Defenders for Different Anthropometric Variables.

Parameters	t-statistic	df	Significance	Mean Difference	Std. Error Difference	95% CI of Difference	
						Lower	Upper
Basic Measurements							
Age (Years)	1.36	18	0.19	2.45	1.80	-1.33	6.24
Height (cm)	2.71	18	**0.01***	6.52	2.41	1.46	11.57
Weight (kg)	0.39	18	0.70	1.23	3.16	-5.41	7.86
Sitting-Height (cm)	1.64	18	0.12	1.93	1.17	-0.54	4.39
Arm Span (cm)	1.40	18	0.18	3.35	2.40	-1.70	8.40
Leg Length (cm)	2.20	18	**0.04***	4.59	2.08	0.21	8.97
BMI (kg/m^2)	-2.01	18	0.06	-1.58	0.78	-3.22	0.07
Skinfolds							
Triceps	-0.19	18	0.85	-0.24	1.24	-2.84	2.36
Subscapular	-0.60	18	0.55	-0.87	1.44	-3.88	2.15
Biceps	-1.23	18	0.24	-0.44	0.36	-1.20	0.31
Iliac Crest	-0.42	18	0.68	-0.81	1.95	-4.90	3.28
Supraspinale	-2.17	18	**0.04***	-1.95	0.90	-3.83	-0.06
Abdominal	-0.49	18	0.63	-1.36	2.77	-7.19	4.47
Front Thigh	-0.24	18	0.82	-0.43	1.83	-4.27	3.40
Calf	-1.77	18	0.09	-1.35	0.76	-2.96	0.25
Girths							
Arm - Relaxed	-0.05	18	0.96	-0.04	0.78	-1.67	1.60
Arm - Flexed	-0.11	18	0.91	-0.07	0.68	-1.50	1.35
Waist	-0.87	18	0.39	-1.64	1.88	-5.60	2.31
Hip	0.14	18	0.89	0.33	2.37	-4.64	5.30
Calf	-0.59	18	0.57	-0.54	0.92	-2.47	1.39
Breadths							
Humerus Breadth	0.80	18	0.43	0.13	0.16	-0.21	0.47
Femur Breadth	-0.76	18	0.46	-0.12	0.16	-0.45	0.21
Corrected Girths							
Corrected Arm	-0.07	18	0.94	-0.05	0.69	-1.50	1.40

Corrected Calf	-0.44	18	0.67	-0.40	0.91	-2.31	1.51
Ratios							
Waist-Hip	-1.12	18	0.28	-0.02	0.02	-0.05	0.02
HWR	2.79	18	**0.01***	1.35	0.48	0.33	2.37
Arm Span to Height	-2.53	18	**0.02***	-0.02	0.01	-0.03	0.00
Somatotype Components							
Endomorph	-1.35	18	0.19	-0.45	0.33	-1.16	0.25
Mesomorph	-2.33	18	**0.03***	-0.89	0.38	-1.68	-0.09
Ectomorph	2.50	18	**0.02***	0.81	0.32	0.13	1.48
Sum of Skinfolds							
Sum of 4 Skinfolds	-0.80	18	0.44	-4.41	5.53	-16.03	7.21
Sum of 6 Skinfolds	-0.83	18	0.42	-6.20	7.47	-21.88	9.49
Sum of 8 Skinfolds	-0.80	18	0.43	-7.45	9.29	-26.96	12.06
Body Fat (%)	-0.80	18	0.44	-0.94	1.18	-3.42	1.53
Fat Mass (kg)	-0.40	18	0.70	-0.46	1.16	-2.89	1.97
Lean Body Mass (kg)	0.65	18	0.53	1.69	2.61	-3.81	7.18

Note: * The mean difference is significant at the $p \leq 0.05$ level.

Significant differences were found between raiders and defenders across multiple anthropometric characteristics. Raiders exhibited significantly higher mean values for height [t (18) = 2.71, p = 0.01], leg length [t (18) = 2.20, p = 0.04], height-weight ratio [t (18) = 2.79, p = 0.01], and ectomorph component [t (18) = 2.50, p = 0.02]. Conversely, defenders displayed significantly higher mean values for supraspinale [t (18) = -2.17, p = 0.04], arm span to height ratio [t (18) = -2.53, p = 0.02], and mesomorph component [t (18) = -2.33, p = 0.03].

The 95% confidence intervals for the differences in means ranged from -3.83 to 11.57 (height = 1.46 to 11.57, leg length = 0.21 to 8.97, supraspinale = -3.83 to -0.06, height-weight ratio = 0.33 to 2.37, arm span to height ratio = -0.03 to 0.00, mesomorph component = -1.68 to -0.09, and ectomorph component = 0.13 to 1.48) for various anthropometric measures, indicating substantial variability across the parameters examined.

Discussion

The key findings of this study established significant differences between raiders and defenders across multiple anthropometric characteristics (Table 1), suggesting distinct physical profiles between raiders and defenders in kabaddi to be present. This highlights the importance of providing individualized position-specific training and conditioning programs to athletes within the sport. Additionally, the confidence intervals for these differences varied widely, highlighting significant variability in the anthropometric measures. This range emphasizes the diverse physical profiles within both raiders and defenders, which should be considered when tailoring these programs.

In terms of body height, a significant difference was found between the body height of raiders and defenders. Raiders exhibited increased leg length when compared to the defenders. Having an increased leg length is beneficial for raiders as it enhances their reach, allowing them to touch opponents and the bonus line more easily. This advantage is crucial in Kabaddi, where frequent leg movements are required to reach opponents or the bonus line. Additionally, longer legs provide better leverage for swift movements and evasive maneuvers.

Increased height has also been shown to intimidate defenders, giving raiders a psychological edge (Sidhu, 2018). A previous study conducted by Mahesh et al. (2022), found that while raiders had a lower mean height than those in the current study, their leg length remained greater. Additionally, Mahesh et al. (2022) found that anthropometric differences between raiders and defenders were limited to hand length and hip circumference only. The contrast in findings may be due to the players recruited for their study being state level kabaddi players, whereas the current study included elite-level professional players. Hence, the focus during selection may have prioritized the player's technical skills over their anthropometric characteristics. These discrepancies in anthropometrics between elite and sub-elite Kabaddi players also mirror findings from other athlete populations, such as rugby, soccer, and fencing (Gabbett et al., 2009; Masanovic et al., 2019; Tsolakis & Vagenas, 2010), demonstrating that higher competitive levels across various sports often require distinct physical attributes. Understanding the typical anthropometrics of the elite Kabaddi player will contribute to identifying players capable of competing at the highest level.

The present study also revealed that defenders have a significantly greater (p=0.02) arm span to height ratio when compared to raiders. Some of the moves that defenders make include grabbing and pulling the opponents along using different hold techniques such as ankle hold, thigh hold and waist hold (Gurule & Muley, 2019). Having a longer arm span allows defenders to cover more area of court and hence effectively allowing them to execute defensive moves more effectively to score points.

In addition to differences in arm span, it was also found that only the supraspinale skinfold site ($p<0.04$) showed a significant difference between the two groups, with the defenders having higher values than the raiders out of the eight skinfold sites. The higher skinfold value suggests that defenders may have a higher proportion of fat in these areas of the body compared to the raiders. The amount of subcutaneous fat at the supraspinale site is indicative of performance parameters such as agility and power to weight ratio. A smaller skinfold at this site is associated with better activation of the abdominal muscles, which enhances the mobility of the pelvic girdle during activity. This improved muscle activation and pelvic mobility contribute to greater agility and efficiency in movement. (Agre et al., 1988). A leaner abdomen also supports better endurance and agility, crucial for maintaining high levels of physical activity during competitions (Canuzakov et al., 2018).

In relation to body fat, it was found that raiders and defenders had similar percentages, with raiders at 16.65% (± 3.04) and defenders at 17.59% (± 2.23). This aligns with findings from other research (Aggarwala et al., 2019; Mahesh et al., 2022), which also reported comparable body fat levels between raiders and defenders. This similarity suggests that body fat percentage alone does not differentiate between these positions, indicating that other factors, such as muscle mass and skill set, may be more relevant in defining a player's position (Dey et al., 1993; Laxmeshwar & Amarnath, 2019).

While the study provides insights into the anthropometric characteristics and somatotypes of elite Kabaddi players, several limitations should be acknowledged. Firstly, the sample size, though sufficient for preliminary analysis, may limit the generalizability of the findings to the broader population of professional Kabaddi players plying their trade in India across different levels and regions. Additionally, the cross-sectional nature of the study prevents the ability to draw conclusions about the causal relationships between anthropometric characteristics and performance outcomes. Furthermore, while the study adheres to established measurement protocols, variability in measurement techniques and inter-rater reliability could introduce some degree of error (Kispert & Merrifield, 1987). Lack of interchangeability has also been observed between the different caliper models, suggesting that using an alternative model may have yielded different results (Esparza-Ros et al., 2022). The use of skinfold measurements and girth assessments, while standard, may not fully capture all relevant aspects of body composition, such as muscle quality or fat distribution, which could influence performance. Lastly, due to the study focusing solely on males, findings may not be directly applicable to female Kabaddi players. Future research should consider larger and more diverse samples of Indian Kabaddi players, explore longitudinal designs to assess changes over time, and incorporate additional methods such as Dual-Energy X-ray Absorptiometry to provide a more comprehensive understanding of body composition and its impact on performance.

Conclusion

In conclusion, the study reveals anthropometric and somatotype differences between raiders and defenders among elite Indian Kabaddi players, highlighting the importance of position-specific training programs to achieve different body compositions. These findings deepen our understanding of how physical attributes and somatotype influence performance in Kabaddi and will aid coaches in optimizing player development and assigning players to the most suitable positions based on their unique physical profiles.

Practical Applications

Anthropometric measurements in elite professional Kabaddi players are crucial for optimizing performance, as they help in identifying the physical attributes best suited for various positions, such as raiders and defenders. Customized training and nutrition plans based on these measurements can enhance a player's strength, agility, and overall fitness, thus reducing injury risks. Moreover, early identification of promising athletes through their anthropometric profiles allows for tailored development programs to be created. Ultimately, this data aids in strategic planning and boosts player confidence by aligning physical capabilities with sport-specific demands.

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Informed Consent Statement

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