IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 Journal UGC CARE Listed (Group-I) Volume 14, Issue 04 2025

Body Composition Variations Across Sports Categories: A Basis For Tailored Sports Training And Nutrition Strategies

Ms. Priyadharshini R[1], Dr. Mrs. Mahjabeen[2]

[1]Ph.D., Research Scholar, Department of Home Science, Justice Basheer Ahmed Sayeed College for Women, Chennai, Tamil Nadu – 600 018. priya.phdscholar2020@gmail.com

[2]Associate Professor and Research Supervisor, Department of Home Science, Justice Basheer Ahmed Sayeed College for Women, Chennai, Tamil Nadu – 600 018, jabeenhasan@gmail.com

Abstract

Body composition is a determining factor in athletic performance, with different sports requiring distinct physiological adaptations. This study investigates variations in body composition across endurance, power, and team sports categories. Athletes in endurance sports- cycling and distance running, generally exhibit lower body fat percentages and enhanced aerobic capacity, achieved through high volumes of moderate-intensity training. Strength athletes, including weightlifters and throwers, possess greater lean body mass but may also have higher fat mass due to increased caloric intake to support muscle hypertrophy. Team sports athletes require a balanced composition of lean muscle and low-fat levels to optimize agility, strength, and endurance. This cross-sectional study included 60 college athletes aged 19-24 years, categorized into three groups: team sports (n=20), endurance (n=20), and power (n=20). Body composition parameters such as skeletal muscle percentage, body fat percentage, visceral fat percentage, and resting metabolic rate were measured. Statistical analyses, including one-way ANOVA and Tukey's post hoc tests, were performed to identify significant differences. Results show that endurance athletes had the lowest body fat percentage (26.10%), visceral fat (2.88), and resting metabolism (1146.15 kcal), while power and team sports athletes exhibited higher values in these parameters. However, differences were not statistically significant ($p > 0.05$). Skeletal muscle distribution patterns varied, with endurance athletes showing the highest total skeletal muscle percentage (27.28%). Despite differences in metabolic demands, the findings highlight the need for sport-specific training and dietary strategies for improving performance. The body composition variations among different sports categories emphasize the need for tailored nutritional and training approaches. Recognizing these variances allows coaches and athletes to implement personalized regimens that maximize performance outcomes. Future studies should investigate how body composition evolves over time and how performance adaptations differ across various sports.

Keywords: Body composition, endurance sports, strength training, team sports, skeletal muscle, fat percentage, nutrition optimization.

INTRODUCTION

Athletic performance and overall health are greatly affected by body composition, with distinct requirements based on the sport. While most athletes benefit from higher lean muscle mass and lower excess fat, specific demands vary depending on the sport's nature (Campa et al., 2021; Heydenreich et al., 2017; Rockwell, n.d.; Walker et al., 2023). Endurance athletes, such as and marathoners and triathletes, typically exhibit low body fat percentages (NSCA's Guide to Tests

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and Assessments, 2017). Elite endurance athletes are often characterized by low body mass and minimal body fat, with male athletes maintaining fat levels between 6 and 13 percent(Azmy et al., n.d.; Campa et al., 2021; Rockwell, n.d.). This reduction in fat mass is primarily achieved through high volumes of lower-intensity exercise.

Conversely, strength-based athletes, such as throwers and wrestlers, depend on substantial muscle mass to achieve peak performance. Compared to endurance athletes and non-athletic individuals they generally have greater appendicular lean mass. While lean mass is prioritized, strength athletes sometimes have higher fat mass compared to endurance athletes due to increased calorie intake aimed at supporting muscle hypertrophy (Campa et al., 2021; Rockwell, n.d.; Walker et al., 2023). This nutritional strategy can inadvertently contribute to higher fat accumulation.

Team sports athletes, for instance those participating in basketball and soccer, require an integration of power, speed, agility, and moderate to high aerobic fitness (Kariyawasam et al., 2019). These athletes gain advantages from having low body fat while preserving or increasing lean body mass. The ideal body composition is influenced by the sport's specific physical demands and the athlete's position (Mathisen et al., 2023). Regular body composition assessments are beneficial for tailoring training plans that optimize body fat reduction while preserving lean mass.

Age-related changes further impact body composition, even among athletes. Studies comparing older (70–89 years) and young (20–39 years) athletes suggests that lifelong engagement in competitive sports lowers the risk of sarcopenic obesity more effectively compared to a recreationally active lifestyle. While strength athletes tend to maintain muscle mass with age, endurance and sprint athletes generally preserve low fat mass levels. Nevertheless, fat mass tends to increase across all athletic disciplines, signifying that exercise alone may not be sufficient to regulate fat accumulation (Chathuranga & Perera, 2022; Rockwell, n.d.; Walker et al., 2023). Complementary interventions, such as dietary modifications, may be required to mitigate shifts in body composition due to aging.

Enhancing athletic performance largely depends on physiological adaptations, which vary according to the unique physical demands of different sports. These adaptations influence the cardiovascular, musculoskeletal, and neuromuscular systems, empowering athletes to optimize endurance, strength, or team-based performance (Hughes et al., 2018; MacInnis & Gibala, 2017). Endurance training induces significant cardiovascular changes, including increased cardiac output, stroke volume, and maximal oxygen consumption (VO2max). These adaptations improve oxygen delivery and utilization, helping to delay muscle fatigue during extended aerobic exercise. High-Intensity Interval Training (HIIT) and Sprint Interval Training (SIT) further boost mitochondrial function and content, leading to enhanced aerobic capacity. Strength training, however, primarily leads to musculoskeletal adaptations without substantial improvements in VO_2max. Team sports athletes exhibit a blend of aerobic and anaerobic adaptations, improving both cardiovascular efficiency and recovery during intermittent high-intensity bursts.

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Based on the training regimen, musculoskeletal adaptations differ. Endurance training promotes mitochondrial biogenesis and increased capillary density in skeletal muscle, improving oxygen delivery and energy production. In contrast, strength training induces muscle hypertrophy by increasing the cross-sectional area (CSA) of muscle fibres, resulting in greater overall strength. This process involves alterations in connective tissue stiffness, which enhances the release of elastic energy by improving the muscle-tendon unit's capacity to store. Team sports athletes develop a combination of strength and endurance adaptations, enabling them to sustain prolonged physical activity while generating explosive movements as required by their sport.

Neuromuscular adaptations further differentiate the physiological responses among athletes. Strength training enhances motor unit recruitment, neural drive, and the rate of force development (RFD), improving the speed and efficiency of force production. Endurance training, while primarily focused on aerobic capacity, also influences neuromuscular function by improving muscle coactivation and eccentric-to-concentric movement transitions. These adaptations allow for more effective use of stored elastic energy, reducing the metabolic cost of exercise. Team sports athletes require highly refined motor coordination, agility, and balance, leading to adaptations that improve neuromuscular control and intermuscular coordination. Such refinements allow athletes to execute complex movements with precision and efficiency (Hughes et al., 2018; MacInnis & Gibala, 2017).

Optimizing training strategies and nutrition plans is indispensable for maximizing athletic performance, with specific requirements differs across various sports (ISSA, 2025). From a nutritional standpoint, endurance athletes require substantial carbohydrate intake to sustain prolonged activity. The required carbohydrate consumption ranges from 8 to 10 grams/kilogram of body weight/day, with additional protein intake (approximately 1.4 grams/kilogram/ day) to support muscle repair. Healthy fats should also constitute around 30% of daily caloric intake to maintain energy balance. Whereas, strength athletes require a protein intake of 20 grams per meal to optimize muscle protein synthesis for muscle development (LeBaigue, 2024). While complex carbohydrates should serve as the primary energy source, strength athletes may benefit from fast-digesting carbohydrates before, during, or after workouts to enhance muscle recovery and glycogen replenishment (Adams, 2024; Dieter, 2024). Team sports athletes require a balance macronutrient intake to accommodate both aerobic and anaerobic energy demands. Carbohydrates should constitute approximately 50% of daily caloric intake, with a focus on whole foods to ensure sustained energy levels. Hydration is also critical, necessitating fluid and electrolyte replenishment to counteract losses incurred during training and competition (ISSA, 2025; Kaiser Permanente, 2024).

OBJECTIVES OF THE STUDY

The primary objective of this study was to evaluate variations in body composition among sportspersons engaged in different sports categories.

1. To compare the body composition parameters among endurance, power, and team sport athletes during the pre-competition period.

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2. To assess the variations in skeletal muscle mass, subcutaneous fat, and visceral fat distribution across different sports categories.
3. To analyse the differences in resting metabolic rate and body age among sportspersons from endurance, power, and team sports groups.

By identifying these differences, the study aimed to provide insights into the physiological adaptations associated with various sporting disciplines. The findings may aid in designing optimized training strategies and nutrition plans that cater to athletes' specific requirements, thereby improving performance and longevity in competitive sports.

METHODOLOGY

Study Design

A cross-sectional design was adopted to analyse body composition variations among young sportspersons engaged in various sports categories.

Study Population and Selection Criteria

The study population consisted of college-going sportspersons in Chennai, aged 19 to 24 years who were actively engaged in competitive sports. Participants were categorized into three groups based on their respective sporting events: Group I (power events), Group II (endurance events), and Group III (team events). Sportspersons who were veterans, non-Indians, or differently abled were excluded from the study to maintain homogeneity in the sample.

Sample Size and Sampling Technique

A total of 60 participants were selected using a random sampling technique. These individuals were further categorized into three primary groups based on their sporting specialization:

- Group I: Endurance events (n=20)
- Group II: Power events (n=20)
- Group III: Team sports (n=20)

Data Collection

Data collection involved the evaluation of various anthropometric and body composition parameters. Height and weight measurements were recorded, and body mass index (BMI) was calculated. The Omron Body Composition Monitor HBF-702T was used to analyse body composition analysis. The parameters assessed included:

1. Body Fat Percentage: Classified into four levels (Low, Normal, High, Very High) based on gender-specific cutoffs (Lohman et al., 1988; Nagamine, 1972).
2. Visceral Fat Level: Categorized as Normal, High, or Very High (OMRON Healthcare figures).
3. Resting Metabolic Rate (RMR): Evaluated according to age and gender-based reference values (Sasaki, 2017).
4. Total Skeletal Muscle Percentage: Interpreted based on standard classification criteria.
5. Segmental Body Composition: Including skeletal muscle percentage and subcutaneous fat percentage for arms, trunk, and legs.

6. Body Age: Estimated based on body composition parameters.

Data Analysis

The collected data were analysed using SPSS 26.0. One-way analysis of variance (ANOVA) was performed to examine differences in body composition parameters across the three groups. Tukey's post hoc test was done to recognize specific group differences when ANOVA indicated significant results. For variables that did not meet normality assumptions, the Kruskal-Wallis test was adopted as a non-parametric alternative to determine statistical differences among the groups.

FINDINGS AND DISCUSSION

The study analysed body composition variation, age, metabolism, skeletal muscle distribution, and fat distribution among sportspersons from endurance, power, and team sports categories. No significant differences were noted in height ($F = 0.364$, $p = 0.697$), weight ($F = 2.223$, $p = 0.118$), or BMI ($F = 1.675$, $p = 0.196$) across the three groups. In all group the BMI was in the normal range, although team sports athletes (23.24 ± 4.26 kg/m²) exhibited the highest BMI and power sports athletes (56.44± 12.13 kg) had higher mean weights, these variations were not statistically significant (Table -1). The study's findings align with previous research comparing the anthropometric measures of athletes in athletics, football, and cycling, highlighting distinctions across different sports categories. The BMI of athletes aged 18–25 years in prior study ranged from 20.68±1.77 to 21.15±1.66 kg/m² (Prajapati et al., 2024), which is lower than the BMI observed in this study (21.04±3.92 to 23.24±4.26 kg/m²). Researches have emphasised that while training-induced adaptations are sport-specific, differences in basic anthropometric measures (height, weight, BMI) might not always be statistical significance (Ackland et al., 2012; Masanovic et al., 2021). These results are comparable with the present study.

Similarly, chronological age did not differ significantly among the groups (power =19.05±1.05, team sports = 19.20±1.20, endurance athletes = 19.50±1.79; $F = 0.548$, $p = 0.581$), and body age differences were also non-significant ($F = 2.054$, $p = 0.138$), despite power (27.60±9.01) and team sports (28.45±9.25) athletes having slightly higher mean body ages than endurance athletes (23.23±7.93). Previous research on young male judo athletes highlighted that older athlete generally performed better, though somatic maturation mitigated age-related advantages, particularly in upper body and handgrip strength (Giudicelli et al., 2021). Similarly, study on football players confirm that relative age, chronological age, and biological maturation influence the accumulated training load; however, perceived exertion remains consistent across different age groups or maturity levels (Teixeira et al., 2022). The impact of age and maturation on athletic performance is well-documented, with chronological age, biological development, and body composition playing crucial roles in determining training load, physical capabilities, and anthropometric differences among athletes across various sports. While age is a contributing factor, other elements, such as body composition and maturation status, can moderate or better explain these effects.

Table -1: Comparison of anthropometric measurements among different sports categories (n=60)

Anthropometric measures	Sports Category	N	Mean	SD	F	p value
Height (cm)	Endurance	20	155.73	5.15	0.364	0.697
	Power	20	156.40	6.44		
	Team sports	20	157.28	5.57		
Weight (kg)	Endurance	20	50.99	8.59	2.223	0.118
	Power	20	56.44	12.13		
	Team sports	20	57.46	10.27		
BMI ($kg.m^{-2}$)	Endurance	20	21.04	3.92	1.675	0.196
	Power	20	22.95	4.19		
	Team sports	20	23.24	4.26		

In terms of body composition, endurance athletes exhibited lower body fat percentage (26.10%), visceral fat level (2.88 ± 2.59), and resting metabolism (1146.15 ± 123.74 kcal/day) compared to power (BF%=29.20 ± 4.99%, VFL=4.15 ± 3.15, RM=1217.85 ± 170.12 kcal/day) and team sports athletes (BF%=29.51 ±6.04%, VFL= 4.30 ± 3.14, RM=1232.85 ± 138.77 kcal/day) (Table -2). However, these differences were not statistically significant ($p > 0.05$). Study shows that athletes generally have higher BMRs than non-athletes, and metabolic adaptations may vary subtly by sport type, but it's not just due to muscle mass. One study reported that non-athletes had a 13% lower BMR compared to athletes when adjusted to fat-free mass (Sjödin et al., 1996). The skeletal muscle distribution analysis revealed that endurance athletes had the highest total skeletal muscle percentage (27.28%), particularly in the arms (31.19%), trunk (22.59%), and legs (38.81%), followed by power and team sports athletes. Prior research infers that muscle mass indicators are determinants of peak power production capacity (Lee et al., 2021). A research on skeletal muscle size distribution stated that female athletes had an average skeletal muscle in (30.0 kg) was around 70% of the average value of the male athletes (45.3 kg) (Abe et al., 2021).

While the difference in arm skeletal muscle percentage approached statistical significance ($F = 2.619$, $p = 0.082$), none of the other muscle distribution differences were significant ($p > 0.05$). The skeletal muscle distribution, specifically in the arms (almost significant- $p = 0.082$), suggests that sport-specific training effects on regional muscle retention have been similarly observed in earlier studies (Ackland et al., 2012; Nakai et al., 2024; Stone et al., 2022). The Kruskal-Wallis test (Table-3) further confirmed the non-significant variations in skeletal muscle percentages across all regions, although a trend was noted for arm muscle percentage ($H = 5.079$, $p = 0.079$), signifying a potential influence of endurance training on upper body muscle retention.

Table -2: Comparison of body composition among different sports categories (n=60)

Body Composition	Sports Category	N	Mean	SD	F	p value
Body Fat (%)	Endurance	20	26.11	4.75	2.526	0.089
	Power	20	29.20	4.99		
	Team sports	20	29.51	6.04		
Visceral Fat Level	Endurance	20	2.88	2.59	1.388	0.258

	Power	20	4.15	3.15		
	Team sports	20	4.30	3.14		
Resting Metabolism (kcal)	Endurance	20	1146.15	123.74	2.028	0.141
	Power	20	1217.85	170.12		
	Team sports	20	1232.85	138.77		
Skeletal Muscle (%)	Endurance	20	27.28	2.01	2.062	0.137
	Power	20	26.11	1.84		
	Team sports	20	26.09	2.48		
Skeletal Muscle（Arms）(%)	Endurance	20	31.19	3.54	2.619	0.082
	Power	20	28.65	4.39		
	Team sports	20	28.41	4.74		
Skeletal Muscle（Trunk）(%)	Endurance	20	22.59	2.27	2.316	0.108
	Power	20	21.17	2.29		
	Team sports	20	21.11	2.78		
Skeletal Muscle（Legs）(%)	Endurance	20	38.81	2.20	0.714	0.494
	Power	20	38.05	1.79		
	Team sports	20	38.28	2.21		
Subcutaneous Fat (%)	Endurance	20	22.63	4.70	2.393	0.100
	Power	20	25.58	5.38		
	Team sports	20	26.06	5.95		
Subcutaneous Fat（Arms）(%)	Endurance	20	38.13	5.36	2.684	0.077
	Power	20	41.95	6.32		
	Team sports	20	42.45	7.48		
Subcutaneous Fat（Trunk）(%)	Endurance	20	18.46	4.75	2.666	0.078
	Power	20	21.48	5.29		
	Team sports	20	22.23	6.23		
Subcutaneous Fat（Legs）(%)	Endurance	20	34.48	5.42	2.647	0.080
	Power	20	38.55	7.29		
	Team sports	20	39.17	8.04		

Regarding subcutaneous fat distribution, endurance athletes had the lowest total subcutaneous fat percentage (22.63%), followed by power (25.58%) and team sports athletes (26.06%), with the difference approaching statistical significance ($F = 2.393$, $p = 0.100$). Subcutaneous fat percentages in the arms ($F = 2.684$, $p = 0.077$) and trunk ($F = 2.666$, $p = 0.078$) also exhibited near-significant differences, particularly between endurance and team sports athletes ($p = 0.095$). These findings indicated that endurance athletes tended to have lower fat accumulation in specific body regions, potentially due to the demands of endurance training. Prior research has consistently demonstrated that endurance athletes generally have lower total body fat and reduced visceral fat than those in team sports and power. It is noted that elite endurance athletes often exhibit lower fat accumulation and higher lean mass in comparison with their counterparts (Gemmink et al., 2020; Heydenreich et al., 2017).

Table -3: Kruskal-Wallis Test for Differences in Skeletal Muscle Percentage Among Three Sports Categories (n=60)

Body Composition	Sports Category	N	Mean Rank	Kruskal-Wallis H	p value
Skeletal Muscle (%)	Endurance	20	36.20	3.2	0.202

ISSN PRINT 2319 1775 Online 2320 7876
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	Power	20	27.58		
	Team Sports	20	27.73		
Skeletal Muscle (Arms) (%)	Endurance	20	37.65	5.079	0.079
	Power	20	27.53		
	Team Sports	20	26.33		
Skeletal Muscle (Trunk) (%)	Endurance	20	36.85	3.969	0.137
	Power	20	27.38		
	Team Sports	20	27.28		
Skeletal Muscle (Legs) (%)	Endurance	20	34.65	1.704	0.427
	Power	20	28.18		
	Team Sports	20	28.68		
Subcutaneous Fat (%)	Endurance	20	23.55	4.843	0.089
	Power	20	33.15		
	Team Sports	20	34.80		
Subcutaneous Fat (Arms) (%)	Endurance	20	23.98	4.298	0.117
	Power	20	32.85		
	Team Sports	20	34.67		
Subcutaneous Fat (Trunk) (%)	Endurance	20	23.50	4.987	0.083
	Power	20	32.88		
	Team Sports	20	35.13		
Subcutaneous Fat (Legs) (%)	Endurance	20	23.25	5.246	0.073
	Power	20	33.38		
	Team Sports	20	34.88		

Although endurance athletes had lower fat percentages, higher skeletal muscle percentages, and lower body ages compared to power and team sports athletes, were not statistically significant different. Endurance athletes have a greater percentage of arm muscle, which corresponds with the physical demands of endurance training. The absence of statistical significance in the findings may be due to the sample size, individual variations, and overlapping physiological demands across sports categories. Further research with larger sample sizes and additional muscle composition assessments could provide further insight into these observed trends.

CONCLUSION

This study highlights the differences in body composition across various sports disciplines and their relevance for optimizing athletic training and nutrition. The results indicate that endurance athletes tend to have lower body fat levels and a greater distribution of skeletal muscle in the legs, enabling enhanced aerobic capacity and endurance performance. In contrast, power athletes demonstrate greater lean body mass and higher resting metabolic rates, essential for strength and explosive performance. Team sports athletes maintain a balance between endurance and power attributes, necessitating an integrative approach to training and nutrition.

While differences in weight, height, and BMI between the groups were not statistically significant, body composition trends align with the physiological demands of each sport. Endurance athletes exhibited lower visceral fat levels and higher resting metabolic rates, supporting prolonged aerobic exertion. Power athletes showed increased muscle mass, particularly in the upper body, contributing to strength and force generation. Team sports athletes displayed a hybrid composition, balancing lean muscle mass with moderate fat levels to support agility, speed, and endurance.

The study emphasizes the importance of tailoring sport-specific training programs and dietary plans to enhance body composition for optimal performance. Endurance athletes benefit from carbohydrate-rich diets and high-volume, low-intensity training, while power athletes require protein-dense nutrition and high-intensity resistance training to support hypertrophy. Team sports athletes necessitate a mixed training approach, combining strength, endurance, and skill-based conditioning, with balanced macronutrient intake to sustain energy demands.

Changes in body composition with age reinforce the need for continuous adjustments in training and nutrition to counteract muscle loss and fat accumulation over time. Sustained participation in competitive sports may contribute to maintaining lean mass and lowering the risk of sarcopenic obesity, emphasizing the long-term benefits of regular physical activity.

Therefore, understanding body composition variations across sports categories enables athletes, coaches, and sports scientists to optimize performance through evidence-based training and nutritional strategies. Future research should explore longitudinal assessments and intervention-based studies to further refine body composition optimization approaches tailored to specific athletic disciplines.

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