Metabolic demands and physical performance in football: a position-specific analysis of energy system utilization

Demandas metabólicas y rendimiento físico en el fútbol: un análisis específico por posición de la utilización del sistema energético

Authors

Awesh Khati [1]
Anindita Das [1]
Purnima Chetry [2]
Lata Apara Deori [1]
Rintu Saibya [3]
Jinnatunnesha Khatun [3]
Debajit Karmakar [1]
Sohom Saha [1]

[1] Lakshmibai National Institute of Physical Education, Gwalior (India)
[2] ITM University, Gwalior (India)
[3] University of Kalyani, Kolkata (India)

Corresponding author:
Sohom Saha
sohomsaha77@gmail.com

How to cite in APA

Khati, A., Das, A., Chetry, P., Deori, L. A., Saibya, R., Khatun, J., Karmakar, D., & Saha, S. (2025). Metabolic demands and physical performance in football: a position-specific analysis of energy system utilization. *Retos, 69*, 785-798. https://doi.org/10.47197/retos.v69.114722

Abstract

Introduction: Football demands a balance of aerobic and anaerobic energy systems, varying by playing position. Midfielders rely on aerobic endurance for sustained movement, while strikers and wingers depend on anaerobic pathways for repeated sprints. Defenders and goalkeepers require anaerobic power for aerial duels and explosive actions. Understanding these demands is essential for optimizing training.
Objective: This study analyzed the metabolic demands and physical performance of collegiate football players across positions, focusing on endurance, speed, vertical jump, and agility.
Methodology: Forty collegiate football players (goalkeepers, defenders, midfielders, strikers) underwent field tests: the 12-Minute Cooper Test (endurance), 50-Meter Sprint Test (speed), Sargent Jump Test (anaerobic power), and Illinois Agility Test. One-way ANOVA and post hoc analysis assessed positional differences.
Results: Significant differences ($p < 0.001$) were found. Midfielders had superior endurance (3306.6 ± 80.2 mt), strikers were fastest (6.43 ± 0.09 sec), goalkeepers had the highest vertical jump (64.6 ± 1.07 cm), and strikers displayed the best agility (14.28 ± 0.58 sec).
Discussion: Results confirm distinct physiological profiles. Midfielders prioritize endurance, while strikers and defenders rely on anaerobic power and speed.
Conclusion: Position-specific training is crucial for optimizing performance and reducing injury risk. Future research should integrate match-specific GPS and metabolic profiling for deeper insights.

Keywords

Aerobic system; anaerobic system; energy system utilization; metabolic demands; position-specific training.

Resumen

Introducción: El fútbol requiere un equilibrio entre los sistemas energéticos aeróbico y anaeróbico, variando según la posición de juego. Los centrocampistas dependen de la resistencia aeróbica para el movimiento sostenido, mientras que los delanteros y extremos utilizan vías anaeróbicas para sprints repetidos. Defensores y porteros necesitan potencia anaeróbica para duelos aéreos y acciones explosivas. Comprender estas demandas es esencial para optimizar el entrenamiento.
Objetivo: Este estudio analizó las demandas metabólicas y el rendimiento físico de futbolistas universitarios según su posición, enfocándose en resistencia, velocidad, salto vertical y agilidad.
Metodología: Cuarenta futbolistas universitarios (porteros, defensores, centrocampistas y delanteros) realizaron pruebas de campo: Test de Cooper de 12 minutos (resistencia), Sprint de 50 metros (velocidad), Test de Salto Sargent (potencia anaeróbica) y Test de Agilidad Illinois. Se empleó ANOVA unidireccional y análisis post hoc para evaluar diferencias posicionales.
Resultados: Se encontraron diferencias significativas ($p < 0.001$). Los centrocampistas destacaron en resistencia (3306.6 ± 80.2 m), los delanteros fueron más rápidos (6.43 ± 0.09 s), los porteros lograron mayor salto vertical (64.6 ± 1.07 cm) y los delanteros mostraron mejor agilidad (14.28 ± 0.58 s).
Discusión: Los resultados confirman perfiles fisiológicos distintos. Los centrocampistas priorizan la resistencia, mientras que delanteros y defensores dependen de la potencia anaeróbica y la velocidad.
Conclusión: El entrenamiento específico por posición es clave para optimizar el rendimiento y reducir el riesgo de lesiones. Investigaciones futuras deberían integrar GPS y perfiles metabólicos en competición para un análisis más profundo.

Palabras clave

Sistema aeróbico; sistema anaeróbico; utilización del sistema energético; demandas metabólicas; entrenamiento específico por posición.

Introduction

Football is a physically demanding, intermittent sport that requires an intricate balance between aerobic and anaerobic energy systems to meet the physiological demands of training and match play (Bangsbo et al., 2007; Manna et al., 2010). The aerobic system facilitates sustained activity and recovery between high-intensity efforts, while the anaerobic system powers short, explosive actions such as sprints, tackles, and goal-scoring opportunities (Bangsbo et al., 2008; Faude et al., 2012a). Given the dynamic nature of football, the extent to which each energy system is utilized varies significantly across playing positions, influenced by tactical roles, physical attributes, and situational demands (Dellal et al., 2011; Sarmento et al., 2014). Midfielders typically cover the greatest distances (11-13 km per match), relying predominantly on aerobic metabolism to maintain endurance and tactical positioning (Bloomfield et al., 2007a; Di Salvo et al., 2007). Their role as the link between defence and attack necessitates exceptional aerobic capacity, with studies reporting higher VO_2 max values compared to other outfield positions (Reilly, Bangsbo, et al., 2000; Tønnessen et al., 2013).

In contrast, forwards and wingers engage in frequent high-speed runs and sprints (>25 km/h), demanding a greater contribution from anaerobic pathways (Ingebrigtsen et al., 2011; Stølen et al., 2005). These players perform 20-40% more high-intensity activities than defenders and central midfielders, highlighting the position-specific metabolic requirements (Bradley, Lago-Peñas, et al., 2013; Mohr et al., 2005a). Defenders, particularly centre backs, rely on both energy systems to sustain positional play, execute rapid accelerations, and engage in aerial duels (Saeidi & Khodamoradi, 2017). Recent research utilizing player tracking technologies has revealed that central defenders perform fewer high-intensity runs but engage in more physical confrontations and jumping actions, emphasizing the importance of anaerobic power and strength in these positions (Baptista et al., 2018). Goalkeepers, in contrast, have a unique physiological profile, with anaerobic power being the primary requirement due to their need for short bursts of explosive movement, reaction saves, and distribution activities (Di Salvo et al., 2007; White et al., 2018; Ziv & Lidor, 2011).

Scientific research has extensively examined the physiological demands of football, highlighting the crucial role of aerobic endurance in sustaining match intensity over 90 minutes (Bangsbo et al., 2008; Stølen et al., 2005). Studies utilizing time-motion analysis and global positioning systems (GPS) have demonstrated that professional footballers cover an average of 10-13 kilometers per match, with midfielders registering the highest distances due to their involvement in both defensive and attacking transitions (Bradley et al., 2009; Mallo et al., 2015; Mohr et al., 2003). The aerobic system provides approximately 90% of the energy requirements during a match, underlining its significance in football performance and recovery between high-intensity efforts (Bangsbo et al., 2006a; Castagna et al., 2003a). On the other hand, attackers and wide players rely more on anaerobic energy pathways to execute repeated sprints and high-intensity dribbles, often exceeding 30 sprints per match (Di Salvo et al., 2010; Rampinini et al., 2007a). These crucial match actions, including goal scoring opportunities, are predominantly fueled by anaerobic metabolism, particularly the phosphagen system for explosive movements lasting 1-5 seconds and glycolytic pathways for sustained high-intensity efforts of 5-30 seconds (Buchheit & Laursen, 2013a; Spencer et al., 2005).

Research by Castagna et al., (2003b) further supports the notion that positional demands dictate the predominant energy system contribution, with central defenders engaging in fewer but more intense physical duels, necessitating both aerobic endurance and anaerobic power. Moreover, studies on collegiate football players have revealed that while the fundamental energy demands align with those of professional players, variations in fitness levels, tactical responsibilities, and match duration impact the overall reliance on specific metabolic pathways (Lockie, Moreno, et al., 2018; Reilly et al., 2008). Collegiate players typically demonstrate lower aerobic capacities (VO_2max of 52-60 ml/kg/min) compared to elite players (55-67 ml/kg/min), potentially influencing their ability to sustain high-intensity efforts throughout a match (Kalapotharakos et al., 2011; McMillan et al., 2005). Furthermore, positional differences in physiological parameters such as sprint ability, vertical jump performance, and agility have been observed in collegiate players, supporting the need for position-specific training interventions (Lago-Peñas et al., 2011; Lockie, Dawes, et al., 2018).

Anaerobic metabolism plays an indispensable role in football performance, particularly during key match events that require maximal effort in short durations. The phosphagen system (ATP-PC) is heavily involved in explosive actions such as acceleration, jumping, and shooting, while anaerobic glycolysis contributes to sustained high-intensity efforts lasting 10-30 seconds (Bishop et al., 2011; Krustrup et al., 2006a). Players performing in high-intensity roles, such as forwards and attacking midfielders, experience repeated bouts of anaerobic exertion, necessitating efficient recovery mechanisms supported by the aerobic system (Osgnach et al., 2010). The ability to rapidly regenerate ATP through oxidative phosphorylation is a critical factor in delaying fatigue and maintaining performance throughout the match (Bangsbo et al., 2007; Mohr et al., 2005b). This is particularly evident in the second half of matches, where decrements in high-intensity running and sprint performance have been observed across all playing positions, albeit to varying degrees (Bradley, Carling, et al., 2013; Mohr et al., 2003). Midfielders, with their superior aerobic capacities, typically experience less pronounced declines compared to forwards and defenders (Di Mascio & Bradley, 2013; Rampinini et al., 2009).

The landscape of football match predictions has evolved, with various statistical measures playing a pivotal role in forecasting results (Karmakar et al., 2024). Recent advancements in metabolic profiling and wearable technology have provided deeper insights into the individualized energy demands of players, emphasizing the need for position-specific conditioning programs (Akenhead & Nassis, 2016; Buchheit & Laursen, 2013b). Contemporary training methodologies have evolved to incorporate small-sided games and high-intensity interval training protocols that simulate the metabolic demands specific to playing positions (Dellal, Hill-Haas, et al., 2011; Malone et al., 2018). Such approaches enhance both aerobic and anaerobic capacities while developing technical and tactical proficiency in context-specific scenarios (Hill-Haas et al., 2011; Impellizzeri et al., 2006a). Vertical jump performance, reflecting lower body power generated primarily through anaerobic pathways, shows marked differences across playing positions, with goalkeepers and central defenders typically demonstrating superior performance due to the frequent aerial demands of their positions (Haugen et al., 2013; Sporis et al., 2009). Similarly, sprint capacity varies significantly by position, with forwards and wide midfielders exhibiting the fastest times over both short (10m) and longer (30m) distances (Haugen et al., 2012; Sporis et al., 2009). Agility has also been identified as a key determinant of football performance, particularly in facilitating rapid directional changes and reactive movements during duels, dribbles, and defensive actions, with research indicating its strong correlation to match-related actions across all playing positions (Chaouachi et al., 2012a; Sheppard & Young, 2006).

This study aims to examine the interplay between aerobic and anaerobic energy systems across different playing positions in collegiate football, focusing specifically on endurance, speed, vertical jump, and agility as key performance indicators. By investigating the metabolic profiles and physical performance characteristics specific to goalkeepers, defenders, midfielders, and strikers, this research will provide valuable insights into the position-specific physiological demands of the sport. The findings will offer practical implications for optimizing training load, enhancing position-specific conditioning protocols, improving fatigue management strategies, and ultimately elevating tactical performance and competitive success in collegiate football.

Method

Participants

The study was comprised of collegiate male football players aged 18 to 23 years who were actively competing at the university level. Participants were selected through purposive sampling from LNIPE, Gwalior, Madhya Pradesh, India. A total of 40 players, representing various playing positions, goalkeepers, defenders, midfielders, and forwards, were included in the study. Eligibility criteria required players to have a minimum of three years of competitive football experience and to be actively engaged in both training and match play. Before participation, all players provided informed written consent. The study was conducted by the principles outlined in the Declaration of Helsinki (WMA - The World Medical Association-Declaration of Helsinki, 2013).

Table 1. Demographic Profiles of Football Players Across Various Playing Positions

	Height	Weight	BMI	Playing Experience

	(Mean±SD)	(Mean±SD)	(Mean±SD)	(Mean±SD)
Goalkeeper	171.5±1.26	61.7±1.49	20.98±0.63	5.70±0.67
Defender	166.6±1.42	62.20±1.87	22.40±0.58	6.10±0.87
Midfielder	165.5±2.01	60.80±1.68	22.21±0.97	5.50±0.70
Striker	165.7±2.40	61.70±2.49	22.50±1.49	5.80±0.78

Procedure

Participants completed a comprehensive field-based assessment to measure key physiological traits: aerobic capacity, anaerobic power, sprint performance, and agility. Initial evaluations included recording anthropometric data such as height, weight, and BMI. Aerobic capacity was measured using the 12-Minute Cooper Test, where the distance covered in 12 minutes reflected endurance. Anaerobic power was assessed via the Sargent Jump Test, recording the highest vertical jump. Sprint performance was evaluated with the 50-Meter Sprint Test, timing how quickly participants covered the distance from a standing start. Agility was measured using the Illinois Agility Test, requiring participants to navigate a course with changes in direction, with total time recorded. To allow for role-specific analysis, data were categorized by playing positions, goalkeepers, defenders, midfielders, and forwards, enabling comparisons of physiological performance across roles.

Instruments

The 12-Minute Cooper Test was employed to quantify aerobic endurance, with the total distance traversed in meters as the primary performance metric (Jaworska et al., 2018). Anaerobic power was evaluated through the Sargent Jump Test, wherein the vertical jump height (measured in centimeters) was recorded using the chalk method (Markovic et al., 2004). Sprint performance was assessed via the 50-meter Sprint Test, wherein the total sprint duration, measured in seconds, was systematically recorded to determine acceleration and maximal velocity (Monea et al., 2017). Agility was evaluated using the Illinois Agility Test, in which participants navigated a standardized course involving straight sprints and directional changes, with total completion time (measured in seconds) serving as the performance metric (Koropanovski et al., 2022). Using manually recorded height and weight measurements, BMI was calculated to objectively evaluate the players' physical composition.

Data Analysis

Descriptive statistics, expressed as mean (M) ± standard deviation (SD), were computed for all measured variables. The Shapiro-Wilk test was employed to examine the normality of data distribution. To assess the influence of playing positions and physical attributes on various performance parameters while controlling for potential confounding factors, one-way ANOVA was performed. For pairwise comparisons where significant differences emerged, the LSD Post Hoc Test was applied. A significance threshold of $p < 0.05$ was set for all statistical analyses, which were conducted using SPSS software (version 26).

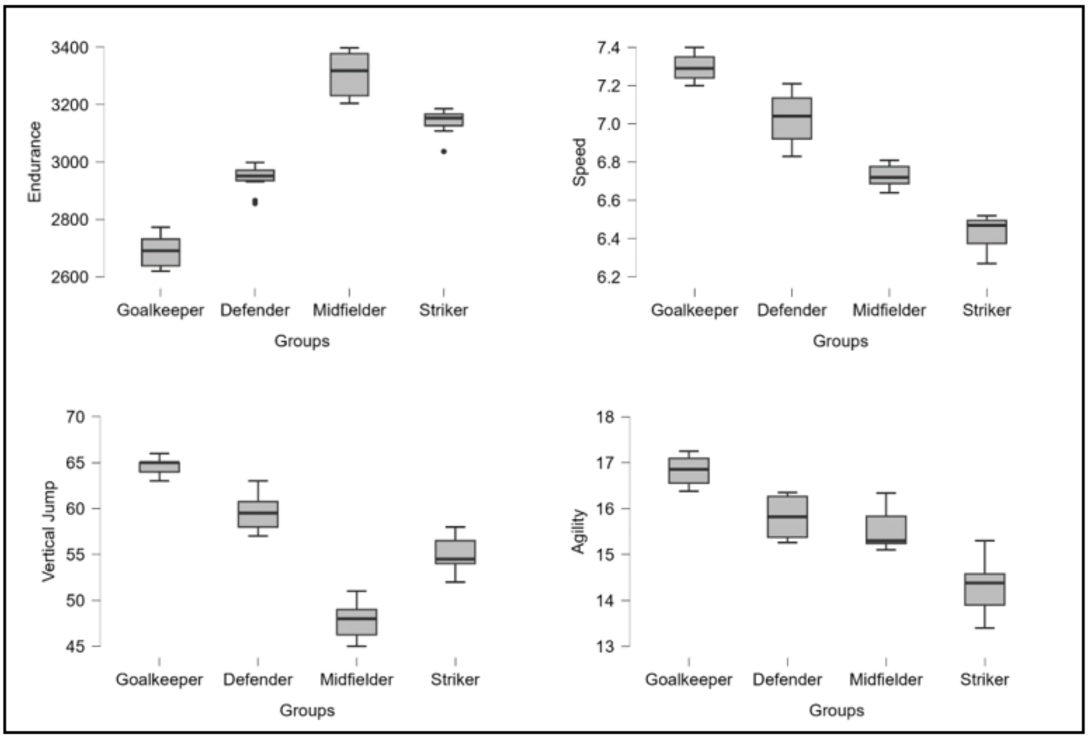
Results

The table 2 illustrates the mean and standard deviation (SD) values for key physical fitness variables, endurance, speed, vertical jump, and agility across different playing positions in football, highlighting the positional specificity of physical performance. Midfielders exhibit the highest endurance (3306.60 ± 80.16), reflecting their need for sustained movement, while goalkeepers record the lowest (2691.00 ± 57.95) due to their limited mobility requirements. Speed performance improves progressively from goalkeepers (7.293 ± 0.071) to strikers (6.434 ± 0.088), aligning with the demand for rapid bursts in offensive play. Vertical jump results indicate superior explosive power among goalkeepers (64.60 ± 1.07) and defenders (59.50 ± 2.07), essential for aerial challenges, while midfielders show the lowest values (47.90 ± 1.91), likely due to endurance prioritization. Agility, critical for quick directional changes, is highest among strikers (14.278 ± 0.576) and progressively slower for midfielders (15.537 ± 0.429), defenders (15.818 ± 0.443), and goalkeepers (16.836 ± 0.330). These findings emphasize how physical attributes are tailored to positional roles, with outfield players excelling in speed and agility, midfielders in endurance, and goalkeepers in explosive power.

Table 2. Descriptive Statistics of Physical Fitness Variables Across Playing Positions

Variables	Playing Position	Mean	SD
Endurance	Goalkeeper	2691.0000	57.95209
	Defender	2943.1000	47.96631
	Midfielder	3306.6000	80.16123
	Striker	3141.9000	44.30814
Speed	Goalkeeper	7.2930	.07103
	Defender	7.0270	.12953
	Midfielder	6.7280	.06015
	Striker	6.4340	.08796
Vertical Jump	Goalkeeper	64.6000	1.07497
	Defender	59.5000	2.06828
	Midfielder	47.9000	1.91195
	Striker	54.8000	2.04396
Agility	Goalkeeper	16.8360	.32992
	Defender	15.8180	.44299
	Midfielder	15.5370	.42929
	Striker	14.2780	.57631

Figure 1. Graphical Representation of Position-Specific Variations in Metabolic Demands and Physical Performance in Football



The table 3 presents the analysis of variance conducted to examine differences in key physical fitness variables including endurance, speed, vertical jump, and agility across different groups. The analysis indicates statistically significant differences for all variables, as evidenced by the high F values and p values of .000. For endurance, the between-groups sum of squares is 2,111,520.900 with an F value of 200.407, indicating substantial variability attributed to group differences, while the within-groups sum of squares is 126,434.200. Speed shows a between-groups sum of squares of 4.138, an F value of 166.300, and a minimal within-groups sum of squares of 0.299, suggesting group membership significantly impacts speed performance. The vertical jump variable also demonstrates notable differences with a between-groups sum of squares of 1,513.000 and an F value of 152.060, while the within-groups sum is 119.400. Similarly, agility shows significant group differences with a between-groups sum of squares of 33.257, an F value of 53.977, and a within-groups sum of 7.394. The consistent p values of

.000 across all variables confirm that these differences are highly significant, indicating that group membership plays a critical role in determining physical fitness performance.

Table 3. Analysis of Variance (ANOVA) for Physical Fitness Variables among Groups

		Sum of Squares	F	*p*
Endurance	Between Groups	2111520.900	200.407	<0.001
	Within Groups	126434.200		
Speed	Between Groups	4.138	166.300	<0.001
	Within Groups	.299		
Vertical Jump	Between Groups	1513.000	152.060	<0.001
	Within Groups	119.400		
Agility	Between Groups	33.257	53.977	<0.001
	Within Groups	7.394		

The table 4 displays the results of the Least Significant Difference (LSD) post hoc analysis, examining differences in physical fitness variables including endurance, speed, vertical jump, and agility among football players occupying different positions: goalkeepers, defenders, midfielders, and strikers. The analysis reveals significant positional differences across all variables. In endurance, goalkeepers demonstrated lower performance compared to defenders, midfielders, and strikers, with mean differences of 252.10000, 615.60000, and 450.90000 respectively, all statistically significant at p less than .001. Defenders also showed lower endurance than midfielders and strikers, with mean differences of 363.50000 and 198.80000, while midfielders outperformed strikers with a mean difference of 164.70000. In speed, goalkeepers were slower than defenders, midfielders, and strikers, with mean differences of 0.26600, 0.56500, and 0.85900. Defenders were slower than midfielders and strikers with mean differences of 0.29900 and 0.59300. Midfielders were also slower than strikers with a mean difference of 0.29400. In vertical jump performance, goalkeepers recorded lower heights than defenders, midfielders, and strikers, with mean differences of 5.10000, 16.70000, and 9.80000 respectively. Defenders demonstrated lower jump heights than midfielders and strikers, with mean differences of 11.60000 and 4.70000, while midfielders outperformed strikers with a mean difference of 6.90000. In agility, goalkeepers were less agile than defenders, midfielders, and strikers, with mean differences of 1.01800, 1.29900, and 2.55800. Defenders were less agile than strikers with a mean difference of 1.54000, though no significant difference was found when compared to midfielders, with a p-value of .174. Midfielders were less agile than strikers with a mean difference of 1.25900. All significant differences were observed at p less than .001, indicating substantial positional variability in physical fitness attributes.

Table 4. LSD Post Hoc Analysis of Physical Fitness Variables among Football Players across Playing Positions

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	*P*
Endurance	Goalkeeper	Defender	-252.10000*	<0.001
		Midfielder	-615.60000*	<0.001
		Striker	-450.90000*	<0.001
	Defender	Midfielder	-363.50000*	<0.001
		Striker	-198.80000*	<0.001
	Midfielder	Striker	164.70*	<0.001
Speed	Goalkeeper	Defender	.26600*	<0.001
		Midfielder	.56500*	<0.001
		Striker	.85900*	<0.001
	Defender	Midfielder	.29900*	<0.001
		Striker	.59300*	<0.001
	Midfielder	Striker	.29400*	<0.001
Vertical Jump	Goalkeeper	Defender	5.10000*	<0.001
		Midfielder	16.70000*	<0.001
		Striker	9.80000*	<0.001
	Defender	Midfielder	11.60000*	<0.001
		Striker	4.70000*	<0.001
	Midfielder	Striker	-6.90000*	<0.001
Agility	Goalkeeper	Defender	1.01800*	<0.001
		Midfielder	1.29900*	<0.001
		Striker	2.55800*	<0.001
	Defender	Midfielder	.28100	0.174

	Striker	1.54000*	<0.001
Midfielder	Striker	1.25900*	<0.001

Discussion

The present study examined the position-specific physical performance characteristics and metabolic demands of football players, revealing significant differences across playing positions in all measured variables: endurance, speed, vertical jump, and agility. These findings provide valuable insights into the unique physiological requirements of each position and have important implications for position-specific training and player development. The results demonstrated highly significant differences in endurance capacity across playing positions (F = 200.407, p < 0.001), with midfielders exhibiting the greatest endurance (M = 3306.60 ± 80.16), followed by strikers (M = 3141.90 ± 44.31), defenders (M = 2943.10 ± 47.97), and goalkeepers (M = 2691.00 ± 57.95). Post-hoc analysis confirmed significant differences between all position pairs (p < 0.001). These findings align with previous research by Bangsbo et al., (2006), who reported that midfielders cover greater distances during matches compared to other positions, necessitating superior aerobic capacity.

Similarly, Di Salvo et al., (2007) found that central midfielders covered significantly greater total distances (11,393 ± 1,016 m) than central defenders (10,627 ± 893 m) and forwards (10,941 ± 1,035 m) during elite-level matches. The superior endurance capacity of midfielders observed in our study can be attributed to their tactical role, which requires continuous movement between defensive and offensive phases (Rampinini et al., 2007b). The relatively high endurance capacity of strikers compared to defenders contradicts some earlier findings (Reilly, Bangsbo, et al., 2000) but supports more recent research by Modric et al., (2019), suggesting that the evolving nature of football tactics has increased the physical demands on attacking players, who are now expected to participate in pressing and defensive transitions. This shift reflects the modern game's emphasis on high-intensity pressing systems, requiring forwards to exhibit greater work capacity (Konefał et al., 2019).

Our analysis revealed significant differences in sprint performance across positions (F = 166.300, p < 0.001), with strikers demonstrating the fastest times (M = 6.43 ± 0.09 s), followed by midfielders (M = 6.73 ± 0.06 s), defenders (M = 7.03 ± 0.13 s), and goalkeepers (M = 7.29 ± 0.07 s). All pairwise comparisons yielded significant differences (p < 0.001). These results support the findings of Sporis et al., (2009), who reported that forwards possessed superior sprinting abilities compared to players in other positions. The enhanced speed of strikers can be explained by the positional demands requiring explosive acceleration and sprint capacity to create separation from defenders and exploit spaces behind defensive lines (Faude et al., 2012b). Indeed, Faude et al., (2012) found that straight sprinting was the most frequent action preceding goal-scoring in professional football, emphasizing the importance of this attribute for attacking players. Our findings revealed that midfielders possessed better speed capabilities than defenders, which contrasts with some previous studies (Gil et al., 2007) but aligns with more recent research by (Slimani et al., 2018).

This finding may reflect the contemporary trend toward more dynamic midfield roles requiring rapid transitions between defensive and offensive phases (Bradley, Lago-Peñas, et al., 2013). The analysis of variance for vertical jump performance revealed significant differences between positions (F = 152.060, p < 0.001), with goalkeepers exhibiting the highest values (M = 64.60 ± 1.07 cm), followed by defenders (M = 59.50 ± 2.07 cm), strikers (M = 54.80 ± 2.04 cm), and midfielders (M = 47.90 ± 1.91 cm). Post-hoc analyses confirmed significant differences between all position pairs (p < 0.001). The superior vertical jump performance of goalkeepers aligns with the findings of Ziv & Lidor, (2011), who attributed this advantage to the specific demands of the goalkeeper position, which frequently requires vertical jumping to intercept high balls.

Similarly, Rebelo-Gonçalves et al., (2015) found that goalkeepers and central defenders demonstrated better jumping performance compared to other positions in football players. The relatively high vertical jump values for defenders compared to attacking players can be explained by the defensive requirements to win aerial duels from crosses and set-pieces (Castagna et al., 2013). Arnason et al., (2004) previously identified a significant relationship between team success in elite football and the jumping capacity of defenders, highlighting the importance of this attribute for defensive play. The lower vertical jump performance of midfielders compared to other positions is consistent with previous research by Di Salvo et al., (2007) and may reflect the different physical demands placed on midfield players, who prioritize endurance and technical skills over power-based attributes. Significant differences in agility performance were observed across playing positions (F = 53.977, $p < 0.001$), with strikers demonstrating the best agility performance (M = 14.28 ± 0.58 s), followed by midfielders (M = 15.54 ± 0.43 s), defenders (M = 15.82 ± 0.44 s), and goalkeepers (M = 16.84 ± 0.33 s).

Post-hoc analyses revealed significant differences between most position pairs ($p < 0.001$), except between defenders and midfielders (p = 0.174). The superior agility of strikers supports research by (Little & Williams, 2005; Stølen et al., 2005), who emphasized the importance of rapid directional changes for attacking players when creating space and evading defenders in confined areas. In a similar context, Chaouachi et al., (2012) noted that elite-level attackers performed significantly better in agility tests compared to defenders and midfielders, attributing this to the position-specific requirement for quick multidirectional movements in attacking situations. The non-significant difference in agility between defenders and midfielders contrasts with some previous findings (Bloomfield et al., 2007b) but aligns with research by Towlson et al., (2017), who found similar agility profiles between these positions. This similarity may reflect the evolving tactical requirements of modern football, where both defenders and midfielders must demonstrate comparable change-of-direction abilities to execute defensive transitions and pressing tactics effectively (Deprez et al., 2015).

The distinct physical profiles observed across playing positions have significant implications for training prescription and talent identification in football. Our findings support the position-specific training approach advocated by (Boone et al., 2012; Reilly, Williams, et al., 2000), suggesting that conditioning programs should be tailored to the unique physiological demands of each position. For midfielders, training should emphasize developing superior aerobic capacity to support their extensive match-running requirements. This aligns with recommendations by (Bangsbo et al., 2006b; Impellizzeri et al., 2006b), who proposed higher volumes of interval training for midfield players compared to other positions. By comparison, training for strikers should prioritize speed and agility development, focusing on explosive movements and directional changes that reflect their match demands (Haugen et al., 2012).

This position-specific approach is supported by research from Mendez-Villanueva et al., (2011), who demonstrated that targeted speed training produced greater improvements in match performance for forwards compared to players in other positions. Defenders and goalkeepers would benefit from programs emphasizing power development to enhance vertical jump performance, supporting the position-specific preparation strategies outlined by (Reilly, Williams, et al., 2000; Ziv & Lidor, 2011). From a talent identification perspective, our findings suggest that the physical attributes most predictive of success vary by playing position, supporting the multidimensional approach to talent identification proposed by (Reilly, Bangsbo, et al., 2000; Williams & and Reilly, 2000). Youth development programs should consider these position-specific physical profiles when evaluating young players and guiding their positional specialization.

Our study provides valuable insights into position-specific physical performance characteristics, but several limitations should be acknowledged. First, our analysis did not account for tactical systems, which may influence the physical demands placed on players within the same nominal position (Bradley et al., 2011). Future research should examine how different playing formations affect the physical profiles of players across positions. In addition, our study utilized standardized fitness tests rather than match-derived performance metrics. Subsequent research could incorporate GPS and time-motion analysis data from competitive matches to provide more ecologically valid measures of position-specific demands, as recommended by (Buchheit et al., 2014; Carling et al., 2008). Furthermore, the energy system utilization was not directly measured through physiological markers such as blood lactate or oxygen consumption. Future studies could incorporate these measures to provide a more comprehensive understanding of the metabolic pathways predominant in different playing positions, building on the work of (Bangsbo et al., 2006b; Krustrup et al., 2006b).

Conclusions

This study provided a comprehensive position-specific analysis of the metabolic demands and physical performance characteristics of collegiate football players, highlighting the significant variations across different playing roles. The findings confirmed that midfielders exhibited superior aerobic endurance, aligning with their role in maintaining tactical positioning and facilitating transitions between offensive and defensive phases. Highlighting the anaerobic demands of football, strikers showed exceptional sprinting speed and agility, essential for creating goal-scoring opportunities and evading defenders. Defenders and goalkeepers displayed greater vertical jump capacity, reinforcing the necessity of anaerobic power for aerial duels and shot-stopping actions, respectively. This research contributed to the field by elucidating the interplay between aerobic and anaerobic energy systems in football, offering empirical evidence to optimize training methodologies. The results underscored the need for position-specific conditioning programs that enhance endurance, speed, agility, and explosive power tailored to the physiological demands of each role. Such insights have implications for performance enhancement, injury prevention, and tactical optimization in football training at the collegiate level and beyond. While this study provided valuable contributions, future research should explore additional physiological markers such as blood lactate accumulation and oxygen uptake to further refine the understanding of energy system utilization. Moreover, integrating wearable technology and GPS tracking in competitive match scenarios could yield more ecologically valid insights into positional demands. Longitudinal studies examining the adaptation of players to different training stimuli may further inform personalized conditioning approaches, ultimately advancing football performance science. The findings of this research serve as a foundation for developing evidence-based training interventions that cater to the evolving demands of modern football.

Acknowledgements

First and foremost, we extend our deepest gratitude to Dr. Anindita Das for her invaluable guidance and expertise throughout the research process. Her insightful feedback, unwavering support, and encouragement significantly enriched the quality and depth of this study. The authors also appreciate the dedication of the participants and the support of the faculty and research staff at LNIPE, Gwalior, India. Lastly, we acknowledge the institutional resources that facilitated the successful completion of this research.

Financing

The authors declare that no financial support or funding was received for this research. The study was conducted independently without any external grants, sponsorships, or institutional financial assistance.

References

Akenhead, R., & Nassis, G. P. (2016). Training Load and Player Monitoring in High-Level Football: Current Practice and Perceptions. International Journal of Sports Physiology and Performance, 11(5), 587–593. https://doi.org/10.1123/ijspp.2015-0331

Arnason, A., Sigurdsson, S. B., Gudmundsson, A., Holme, I., Engebretsen, L., & Bahr, R. (2004). Physical fitness, injuries, and team performance in soccer. Medicine and Science in Sports and Exercise, 36(2), 278–285. https://doi.org/10.1249/01.MSS.0000113478.92945.CA

Bangsbo, J., Iaia, F. M., & Krustrup, P. (2007). Metabolic response and fatigue in soccer. International Journal of Sports Physiology and Performance, 2(2), 111–127. https://doi.org/10.1123/ijspp.2.2.111

Bangsbo, J., Iaia, F. M., & Krustrup, P. (2008). The Yo-Yo intermittent recovery test: A useful tool for evaluation of physical performance in intermittent sports. Sports Medicine (Auckland, N.Z.), 38(1), 37–51. https://doi.org/10.2165/00007256-200838010-00004

Bangsbo, J., Mohr, M., & Krustrup, P. (2006a). Physical and metabolic demands of training and match-play in the elite football player. Journal of Sports Sciences, 24(7), 665–674. https://doi.org/10.1080/02640410500482529

Bangsbo, J., Mohr, M., & Krustrup, P. (2006b). Physical and metabolic demands of training and match-play in the elite football player. Journal of Sports Sciences, 24(7), 665–674. https://doi.org/10.1080/02640410500482529

Baptista, I., Johansen, D., Seabra, A., & Pettersen, S. A. (2018). Position specific player load during match-play in a professional football club. PloS One, 13(5), e0198115. https://doi.org/10.1371/journal.pone.0198115

Bishop, D., Girard, O., & Mendez-Villanueva, A. (2011). Repeated-sprint ability - part II: Recommendations for training. Sports Medicine (Auckland, N.Z.), 41(9), 741–756. https://doi.org/10.2165/11590560-000000000-00000

Bloomfield, J., Polman, R., & O'Donoghue, P. (2007a). Physical Demands of Different Positions in FA Premier League Soccer. Journal of Sports Science & Medicine, 6, 63–70.

Bloomfield, J., Polman, R., & O'Donoghue, P. (2007b). Physical Demands of Different Positions in FA Premier League Soccer. Journal of Sports Science & Medicine, 6(1), 63–70.

Boone, J., Vaeyens, R., Steyaert, A., Vanden Bossche, L., & Bourgois, J. (2012). Physical fitness of elite Belgian soccer players by player position. Journal of Strength and Conditioning Research, 26(8), 2051–2057. https://doi.org/10.1519/JSC.0b013e318239f84f

Bradley, P. S., Carling, C., Archer, D., Roberts, J., Dodds, A., Di Mascio, M., Paul, D., Diaz, A. G., Peart, D., & Krustrup, P. (2011). The effect of playing formation on high-intensity running and technical profiles in English FA Premier League soccer matches. Journal of Sports Sciences, 29(8), 821–830. https://doi.org/10.1080/02640414.2011.561868

Bradley, P. S., Carling, C., Gomez Diaz, A., Hood, P., Barnes, C., Ade, J., Boddy, M., Krustrup, P., & Mohr, M. (2013). Match performance and physical capacity of players in the top three competitive standards of English professional soccer. Human Movement Science, 32(4), 808–821. https://doi.org/10.1016/j.humov.2013.06.002

Bradley, P. S., Lago-Peñas, C., Rey, E., & Gomez Diaz, A. (2013). The effect of high and low percentage ball possession on physical and technical profiles in English FA Premier League soccer matches. Journal of Sports Sciences, 31(12), 1261–1270. https://doi.org/10.1080/02640414.2013.786185

Bradley, P. S., Sheldon, W., Wooster, B., Olsen, P., Boanas, P., & Krustrup, P. (2009). High-intensity running in English FA Premier League soccer matches. Journal of Sports Sciences, 27(2), 159–168. https://doi.org/10.1080/02640410802512775

Buchheit, M., Allen, A., Poon, T. K., Modonutti, M., Gregson, W., & Di Salvo, V. (2014). Integrating different tracking systems in football: Multiple camera semi-automatic system, local position measurement and GPS technologies. Journal of Sports Sciences, 32(20), 1844–1857. https://doi.org/10.1080/02640414.2014.942687

Buchheit, M., & Laursen, P. B. (2013a). High-intensity interval training, solutions to the programming puzzle: Part I: cardiopulmonary emphasis. Sports Medicine (Auckland, N.Z.), 43(5), 313–338. https://doi.org/10.1007/s40279-013-0029-x

Buchheit, M., & Laursen, P. B. (2013b). High-intensity interval training, solutions to the programming puzzle: Part I: cardiopulmonary emphasis. Sports Medicine (Auckland, N.Z.), 43(5), 313–338. https://doi.org/10.1007/s40279-013-0029-x

Carling, C., Bloomfield, J., Nelsen, L., & Reilly, T. (2008). The role of motion analysis in elite soccer: Contemporary performance measurement techniques and work rate data. Sports Medicine (Auckland, N.Z.), 38(10), 839–862. https://doi.org/10.2165/00007256-200838100-00004

Castagna, C., D'Ottavio, S., & Abt, G. (2003a). Activity profile of young soccer players during actual match play. Journal of Strength and Conditioning Research, 17(4), 775–780. https://doi.org/10.1519/1533-4287(2003)017<0775:apoysp>2.0.co;2

Castagna, C., D'Ottavio, S., & Abt, G. (2003b). Activity profile of young soccer players during actual match play. Journal of Strength and Conditioning Research, 17(4), 775–780. https://doi.org/10.1519/1533-4287(2003)017<0775:apoysp>2.0.co;2

Castagna, C., Ganzetti, M., Ditroilo, M., Giovannelli, M., Rocchetti, A., & Manzi, V. (2013). Concurrent validity of vertical jump performance assessment systems. Journal of Strength and Conditioning Research, 27(3), 761–768. https://doi.org/10.1519/JSC.0b013e31825dbcc5

Chaouachi, A., Manzi, V., Chaalali, A., Wong, D. P., Chamari, K., & Castagna, C. (2012a). Determinants analysis of change-of-direction ability in elite soccer players. Journal of Strength and Conditioning Research, 26(10), 2667–2676. https://doi.org/10.1519/JSC.0b013e318242f97a

Chaouachi, A., Manzi, V., Chaalali, A., Wong, D. P., Chamari, K., & Castagna, C. (2012b). Determinants analysis of change-of-direction ability in elite soccer players. Journal of Strength and Conditioning Research, 26(10), 2667–2676. https://doi.org/10.1519/JSC.0b013e318242f97a

Dellal, A., Chamari ,Karim, Wong ,Del P., Ahmaidi ,Said, Keller ,Dominique, Barros ,Ricardo, Bisciotti ,Gian Nicola, & and Carling, C. (2011). Comparison of physical and technical performance in European soccer match-play: FA Premier League and La Liga. European Journal of Sport Science, 11(1), 51–59. https://doi.org/10.1080/17461391.2010.481334

Dellal, A., Hill-Haas, S., Lago-Penas, C., & Chamari, K. (2011). Small-sided games in soccer: Amateur vs. professional players' physiological responses, physical, and technical activities. Journal of Strength and Conditioning Research, 25(9), 2371–2381. https://doi.org/10.1519/JSC.0b013e3181fb4296

Deprez, D., Fransen, J., Boone, J., Lenoir, M., Philippaerts, R., & Vaeyens, R. (2015). Characteristics of high-level youth soccer players: Variation by playing position. Journal of Sports Sciences, 33(3), 243–254. https://doi.org/10.1080/02640414.2014.934707

Di Mascio, M., & Bradley, P. S. (2013). Evaluation of the most intense high-intensity running period in English FA premier league soccer matches. Journal of Strength and Conditioning Research, 27(4), 909–915. https://doi.org/10.1519/JSC.0b013e31825ff099

Di Salvo, V., Baron, R., González-Haro, C., Gormasz, C., Pigozzi, F., & Bachl, N. (2010). Sprinting analysis of elite soccer players during European Champions League and UEFA Cup matches. Journal of Sports Sciences, 28(14), 1489–1494. https://doi.org/10.1080/02640414.2010.521166

Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F. J., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. International Journal of Sports Medicine, 28(3), 222–227. https://doi.org/10.1055/s-2006-924294

Faude, O., Koch, T., & Meyer, T. (2012a). Straight sprinting is the most frequent action in goal situations in professional football. Journal of Sports Sciences, 30(7), 625–631. https://doi.org/10.1080/02640414.2012.665940

Faude, O., Koch, T., & Meyer, T. (2012b). Straight sprinting is the most frequent action in goal situations in professional football. Journal of Sports Sciences, 30(7), 625–631. https://doi.org/10.1080/02640414.2012.665940

Gil, S. M., Gil, J., Ruiz, F., Irazusta, A., & Irazusta, J. (2007). Physiological and anthropometric characteristics of young soccer players according to their playing position: Relevance for the selection process. Journal of Strength and Conditioning Research, 21(2), 438–445. https://doi.org/10.1519/R-19995.1

Haugen, T. A., Tønnessen, E., & Seiler, S. (2012). Speed and countermovement-jump characteristics of elite female soccer players, 1995-2010. International Journal of Sports Physiology and Performance, 7(4), 340–349. https://doi.org/10.1123/ijspp.7.4.340

Haugen, T. A., Tønnessen, E., & Seiler, S. (2013). Anaerobic performance testing of professional soccer players 1995-2010. International Journal of Sports Physiology and Performance, 8(2), 148–156. https://doi.org/10.1123/ijspp.8.2.148

Hill-Haas, S. V., Dawson, B., Impellizzeri, F. M., & Coutts, A. J. (2011). Physiology of small-sided games training in football: A systematic review. Sports Medicine (Auckland, N.Z.), 41(3), 199–220. https://doi.org/10.2165/11539740-000000000-00000

Impellizzeri, F. M., Marcora, S. M., Castagna, C., Reilly, T., Sassi, A., Iaia, F. M., & Rampinini, E. (2006a). Physiological and performance effects of generic versus specific aerobic training in soccer players. International Journal of Sports Medicine, 27(6), 483–492. https://doi.org/10.1055/s-2005-865839

Impellizzeri, F. M., Marcora, S. M., Castagna, C., Reilly, T., Sassi, A., Iaia, F. M., & Rampinini, E. (2006b). Physiological and performance effects of generic versus specific aerobic training in soccer players. International Journal of Sports Medicine, 27(6), 483–492. https://doi.org/10.1055/s-2005-865839

Ingebrigtsen, J., Dillern, T., & Shalfawi, S. A. (2011). Aerobic capacities and anthropometric characteristics of elite female soccer players. Journal of Strength and Conditioning Research, 25(12), 3352–3357. https://doi.org/10.1519/JSC.0b013e318215f763

Jaworska, L., Hawrylak, A., Burzyński, B., & Szczepańska-Gieracha, J. (2018). Effect of progressive muscle relaxation on pain threshold and effectiveness of footballers' training. Human Movement, 16(4), 225–228. https://doi.org/10.1515/humo-2015-0043

Kalapotharakos, V. I., Ziogas, G., & Tokmakidis, S. P. (2011). Seasonal aerobic performance variations in elite soccer players. Journal of Strength and Conditioning Research, 25(6), 1502–1507. https://doi.org/10.1519/JSC.0b013e3181da85a9

Karmakar, D., Saha, S., Elayaraja, M., Das, A., Sharma, Borah, P., Gogoi, L., Gogoi, H., & Govindasamy, K. (2024). Uncovering Determinants of Victory and Defeat in Men's UEFA Champions League: An Analytical Exploration Using Logistic Regression. Studia Sportiva, 18, 51–62. https://doi.org/10.5817/StS2024-2-5

Konefał, M., Chmura, P., Zając, T., Chmura, J., Kowalczuk, E., & Andrzejewski, M. (2019). Evolution of technical activity in various playing positions, in relation to match outcomes in professional soccer. Biology of Sport, 36(2), 181–189. https://doi.org/10.5114/biolsport.2019.83958

Koropanovski, N., Orr, R. M., Dopsaj, M., Heinrich, K. M., Dawes, J. J., & Kukic, F. (2022). Effects of Maximal and Submaximal Anaerobic and Aerobic Running on Subsequent Change-of-Direction Speed Performance among Police Students. Biology, 11(5), 767. https://doi.org/10.3390/biology11050767

Krustrup, P., Mohr, M., Steensberg, A., Bencke, J., Kjaer, M., & Bangsbo, J. (2006a). Muscle and blood metabolites during a soccer game: Implications for sprint performance. Medicine and Science in Sports and Exercise, 38(6), 1165–1174. https://doi.org/10.1249/01.mss.0000222845.89262.cd

Krustrup, P., Mohr, M., Steensberg, A., Bencke, J., Kjaer, M., & Bangsbo, J. (2006b). Muscle and blood metabolites during a soccer game: Implications for sprint performance. Medicine and Science in Sports and Exercise, 38(6), 1165–1174. https://doi.org/10.1249/01.mss.0000222845.89262.cd

Lago-Peñas, C., Casais, L., Dellal, A., Rey, E., & Domínguez, E. (2011). Anthropometric and physiological characteristics of young soccer players according to their playing positions: Relevance for competition success. Journal of Strength and Conditioning Research, 25(12), 3358–3367. https://doi.org/10.1519/JSC.0b013e318216305d

Little, T., & Williams, A. G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. Journal of Strength and Conditioning Research, 19(1), 76–78. https://doi.org/10.1519/14253.1

Lockie, R. G., Dawes, J. J., & Jones, M. T. (2018). Relationships between Linear Speed and Lower-Body Power with Change-of-Direction Speed in National Collegiate Athletic Association Divisions I and II Women Soccer Athletes. Sports (Basel, Switzerland), 6(2), 30. https://doi.org/10.3390/sports6020030

Lockie, R. G., Moreno, M. R., Lazar, A., Orjalo, A. J., Giuliano, D. V., Risso, F. G., Davis, D. L., Crelling, J. B., Lockwood, J. R., & Jalilvand, F. (2018). The Physical and Athletic Performance Characteristics of Division I Collegiate Female Soccer Players by Position. Journal of Strength and Conditioning Research, 32(2), 334–343. https://doi.org/10.1519/JSC.0000000000001561

Mallo, J., Mena, E., Nevado, F., & Paredes, V. (2015). Physical Demands of Top-Class Soccer Friendly Matches in Relation to a Playing Position Using Global Positioning System Technology. Journal of Human Kinetics, 47, 179–188. https://doi.org/10.1515/hukin-2015-0073

Malone, S., Owen, A., Newton, M., Mendes, B., Tiernan, L., Hughes, B., & Collins, K. (2018). Wellbeing perception and the impact on external training output among elite soccer players. Journal of Science and Medicine in Sport, 21(1), 29–34. https://doi.org/10.1016/j.jsams.2017.03.019

Manna, I., Khanna, G. L., & Chandra Dhara, P. (2010). Effect of training on physiological and biochemical variables of soccer players of different age groups. Asian Journal of Sports Medicine, 1(1), 5–22. https://doi.org/10.5812/asjsm.34875

Markovic, G., Dizdar, D., Jukic, I., & Cardinale, M. (2004). Reliability and factorial validity of squat and countermovement jump tests. Journal of Strength and Conditioning Research, 18(3), 551–555. https://doi.org/10.1519/1533-4287(2004)18<551:RAFVOS>2.0.CO;2

McMillan, K., Helgerud, J., Macdonald, R., & Hoff, J. (2005). Physiological adaptations to soccer specific endurance training in professional youth soccer players. British Journal of Sports Medicine, 39(5), 273–277. https://doi.org/10.1136/bjsm.2004.012526

Mendez-Villanueva, A., Buchheit, M., Simpson, B., Peltola, E., & Bourdon, P. (2011). Does on-field sprinting performance in young soccer players depend on how fast they can run or how fast they do run? Journal of Strength and Conditioning Research, 25(9), 2634–2638. https://doi.org/10.1519/JSC.0b013e318201c281

Modric, T., Versic, S., Sekulic, D., & Liposek, S. (2019). Analysis of the Association between Running Performance and Game Performance Indicators in Professional Soccer Players. International Journal of Environmental Research and Public Health, 16(20), 4032. https://doi.org/10.3390/ijerph16204032

Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. Journal of Sports Sciences, 21(7), 519–528. https://doi.org/10.1080/0264041031000071182

Mohr, M., Krustrup, P., & Bangsbo, J. (2005a). Fatigue in soccer: A brief review. Journal of Sports Sciences, 23, 593–599. https://doi.org/10.1080/02640410400021286

Mohr, M., Krustrup, P., & Bangsbo, J. (2005b). Fatigue in soccer: A brief review. Journal of Sports Sciences, 23, 593–599. https://doi.org/10.1080/02640410400021286

Monea, D., Prodan, R., & Grosu, V. T. (2017). Specific training for improving the skill and speed in junior football players. Timisoara Physical Education and Rehabilitation Journal, 10(19), 207–215. https://doi.org/10.1515/tperj-2017-0043

Osgnach, C., Poser, S., Bernardini, R., Rinaldo, R., & di Prampero, P. E. (2010). Energy cost and metabolic power in elite soccer: A new match analysis approach. Medicine and Science in Sports and Exercise, 42(1), 170–178. https://doi.org/10.1249/MSS.0b013e3181ae5cfd

Rampinini, E., Coutts, A. J., Castagna, C., Sassi, R., & Impellizzeri, F. M. (2007a). Variation in top level soccer match performance. International Journal of Sports Medicine, 28(12), 1018–1024. https://doi.org/10.1055/s-2007-965158

Rampinini, E., Coutts, A. J., Castagna, C., Sassi, R., & Impellizzeri, F. M. (2007b). Variation in top level soccer match performance. International Journal of Sports Medicine, 28(12), 1018–1024. https://doi.org/10.1055/s-2007-965158

Rampinini, E., Impellizzeri, F. M., Castagna, C., Coutts, A. J., & Wisløff, U. (2009). Technical performance during soccer matches of the Italian Serie A league: Effect of fatigue and competitive level. Journal of Science and Medicine in Sport, 12(1), 227–233. https://doi.org/10.1016/j.jsams.2007.10.002

Rebelo-Gonçalves, R., Coelho-e-Silva, M. J., Severino, V., Tessitore, A., & Figueiredo, A. J. B. (2015). Anthropometric and physiological profiling of youth soccer goalkeepers. International Journal of Sports Physiology and Performance, 10(2), 224–231. https://doi.org/10.1123/ijspp.2014-0181

Reilly, T., Bangsbo, J., & Franks, A. (2000). Anthropometric and physiological predispositions for elite soccer. Journal of Sports Sciences, 18(9), 669–683. https://doi.org/10.1080/02640410050120050

Reilly, T., Drust, B., & Clarke, N. (2008). Muscle fatigue during football match-play. Sports Medicine (Auckland, N.Z.), 38(5), 357–367. https://doi.org/10.2165/00007256-200838050-00001

Reilly, T., Williams, A. M., Nevill, A., & Franks, A. (2000). A multidisciplinary approach to talent identification in soccer. Journal of Sports Sciences, 18(9), 695–702. https://doi.org/10.1080/02640410050120078

Saeidi, A., & Khodamoradi, A. (2017). Physical and Physiological Demand of Soccer Player Based on Scientific Research.

Sarmento, H., Marcelino, R., Campanico, J., Matos, N., & Leitão, J. (2014). Match analysis in football: A systematic review. Journal of Sports Sciences, 32, 1831–1843. https://doi.org/10.1080/02640414.2014.898852

Sheppard, J. M., & Young, W. B. (2006). Agility literature review: Classifications, training and testing. Journal of Sports Sciences, 24(9), 919–932. https://doi.org/10.1080/02640410500457109

Slimani, M., Miarka, B., & Bragazzi, N. (2018). Maximum Oxygen Uptake of Male Soccer Players According to their Competitive Level, Playing Position and Age Group: Implication from a Network Meta-Analysis. Journal of Human Kinetics, 66. https://doi.org/10.2478/hukin-2018-0060

Spencer, M., Bishop, D., Dawson, B., & Goodman, C. (2005). Physiological and metabolic responses of repeated-sprint activities:specific to field-based team sports. Sports Medicine (Auckland, N.Z.), 35(12), 1025–1044. https://doi.org/10.2165/00007256-200535120-00003

Sporis, G., Jukic, I., Ostojic, S. M., & Milanovic, D. (2009). Fitness profiling in soccer: Physical and physiologic characteristics of elite players. Journal of Strength and Conditioning Research, 23(7), 1947–1953. https://doi.org/10.1519/JSC.0b013e3181b3e141

Stølen, T., Chamari, K., Castagna, C., & Wisløff, U. (2005). Physiology of soccer: An update. Sports Medicine (Auckland, N.Z.), 35(6), 501–536. https://doi.org/10.2165/00007256-200535060-00004

Tønnessen, E., Hem, E., Leirstein, S., Haugen, T., & Seiler, S. (2013). Maximal aerobic power characteristics of male professional soccer players, 1989-2012. International Journal of Sports Physiology and Performance, 8(3), 323–329. https://doi.org/10.1123/ijspp.8.3.323

Towlson, C., Cobley, S., Midgley, A. W., Garrett, A., Parkin, G., & Lovell, R. (2017). Relative Age, Maturation and Physical Biases on Position Allocation in Elite-Youth Soccer. International Journal of Sports Medicine, 38(3), 201–209. https://doi.org/10.1055/s-0042-119029

White, A., Hills, S. P., Cooke, C. B., Batten, T., Kilduff, L. P., Cook, C. J., Roberts, C., & Russell, M. (2018). Match-Play and Performance Test Responses of Soccer Goalkeepers: A Review of Current Literature. Sports Medicine (Auckland, N.Z.), 48(11), 2497–2516. https://doi.org/10.1007/s40279-018-0977-2

Williams, A. M., & and Reilly, T. (2000). Talent identification and development in soccer. Journal of Sports Sciences, 18(9), 657–667. https://doi.org/10.1080/02640410050120041

WMA - The World Medical Association-Declaration of Helsinki. (2013). https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/

Ziv, G., & Lidor, R. (2011). Physical characteristics, physiological attributes, and on-field performances of soccer goalkeepers. International Journal of Sports Physiology and Performance, 6(4), 509–524. https://doi.org/10.1123/ijspp.6.4.509

Authors' and translators' details:

Awesh Khati	awesh19@gmail.com	Author
Anindita Das	anindita416@gmail.com	Author
Purnima Chetry	purnimachetry29@gmail.com	Author
Lata Apara Deori	aparadeorilata96@gmail.com	Author
Rintu Saibya	rintusaibo@gmail.com	Author
Jinnatunnesha Khatun	jinnatjyoti@gmail.com	Author
Debajit Karmakar	debajitkarmakar2200@gmail.com	Author
Sohom Saha	sohomsaha77@gmail.com	Translator