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Body Composition and Agility as Determinants of Kabaddi Performance: A Cross-Sectional Study

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Abstract: *Kabaddi is a team sport that requires physical strength, agility, endurance, and offensive and defensive skills. Body composition, such as muscle mass, fat-free mass, and fat mass, is believed to influence performance. This study analyzes the relationship between body composition, agility, and the performance of kabaddi athletes, as well as the contribution of each variable to the performance of kabaddi athletes. This correlational study with a cross-sectional approach involved 32 active kabaddi athletes from East Java. Data collection was carried out by measuring waist circumference with a measuring tape, while muscle mass, fat-free mass (FFM), and fat mass were measured using bioelectrical impedance analysis (BIA) with the InBody 270; agility was assessed with the T-agility test, and kabaddi performance was evaluated by experts based on raiding, catching, and teamwork skills. The results showed that muscle mass had the strongest correlation with kabaddi performance (r=0.957, p=0.001), followed by fat-free mass (r=0.937, p=0.001) and waist circumference (r=0.749, p=0.001), while fat mass showed a lower significant correlation (r=0.512, p=0.010). Agility showed a significant negative correlation (r=-0.775, p=0.001), where faster agility test times were associated with better performance. The regression model explained 95.3% of the variability in kabaddi performance. In conclusion, muscle mass, fat-free mass, and agility are the main predictors of kabaddi athlete performance, while fat mass and waist circumference had minimal impact.*

Keyword: *Kabaddi, Body composition, Agility, Physical strength, Endurance*

Introduction

Kabaddi is a martial art that lasts 40 minutes, interspersed with a 5-minute break (20-5-20). The game aims to touch as many defenders as possible without running out of breath while charging into the opponent's area to score points (Singh, 2023). Therefore, one can gauge a player's Kabaddi performance by the number of points they score in a 40-minute period. Kabaddi is a team contact sport that requires high endurance, explosive power, strength, agility, response time, spatial awareness, and speed (Anita et al., 2020). Players must move quickly and think quickly, requiring quick reflexes and decision-making abilities even outside the game (Singh, 2023). The combination of movements in this sport, such as jumping, dodging, turning, pushing, and falling, increases the risk of injury for each athlete (Dahiya and Kumar, 2023). Therefore, we can conclude that agility plays a crucial role in kabaddi performance. Consequently, Kabaddi players focus their training regimens on agility (Prakash et al., 2021).

The literature well documents the importance of agility in kabaddi. According to Muthukumar and Kumaresan (2019), the most important motor skill in Kabaddi is agility. Majlesi et al. (2012) state that in order to evade adversary grappling, each player must have a high level of speed, particularly while changing directions, in order to catch their opponents successfully (Mamgain, 2021; Patel Ankur Chaturbhai and Dr. Gagan Vyas, 2023). An athlete's agility directly impacts the fast-paced game of Kabaddi, which involves sprinting, dodging, and quick reflexes (De et al., 1982). An athlete's agility directly influences the need for "both aerobic and anaerobic endurance with a well-built physique," according to another study on Indian national kabaddi players (Dey, Khanna, and Batra, 1993). Yallap and Munireddy (2019) found that training with shuttle runs to increase speed did not significantly affect the performance of kabaddi athletes (Utama et al., 2022).

Kabaddi differs from other sports in that it involves direct physical contact with the opponent, necessitating a

good body composition and agility to avoid or attack the opponent for optimal performance (Kumar, Nara, and Dhull, 2023). Therefore, we anticipate that body composition, including aspects like muscle mass, body fat percentage, and lean body mass, will significantly influence a Kabaddi player's level of success (Kumar Kaushik et al., 2018). It is possible that athletes with varied body compositions would experience a variety of benefits and drawbacks when participating in this activity. In order to improve player growth and overall success, it is essential for players, coaches, and sports scientists to have a solid understanding of the link between body composition and Kabaddi performance (Johnson and Ivarsson, 2017).

Kabaddi is a sport that emphasizes physical strength, agility, endurance, and defensive and attacking abilities, so optimal body parameters are key to athlete success (Aggarwala et al., 2019). High muscle mass and low fat mass contribute to increased strength and agility (Dharmajayanti, Negara, and Artini, 2023), while proportional waist circumference correlates with better movement ability and endurance (Devaraju & Kalidasan, 2012). Fat-free mass, as a primary indicator of muscle strength, plays a major role in intense physical activities such as attacking and defending in kabaddi (Portella et al. 2014; Roy and Sarkar, 2022). However, despite evidence supporting the importance of body composition in other sports such as football and wrestling, specific research examining the direct relationship between these body components and specific performance in kabaddi is limited. Most studies focus more on the general benefits of physical fitness without taking into account the unique physiological and biomechanical needs of kabaddi. Furthermore, the majority of studies have focused on general athlete populations, neglecting contextual factors like player positions (raider or defender) or variations in competition levels. This study intends to bridge this gap by thoroughly examining the impact of waist circumference, muscle mass, fat-free mass, and fat mass on kabaddi performance, thereby offering more precise guidance for kabaddi athlete training and evaluation programs.

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Method

Study design and participants

This type of research is a correlational study that uses a cross-sectional approach to identify the relationship between body composition, agility, and performance of Kabaddi athletes. All 34 East Java kabaddi athletes, who were still actively competing in official national tournaments and had no history of serious injuries or medical conditions that affected performance, comprised the population. The determination of the number of samples was calculated using the Slovin formula with a margin of error of 5%, and a value of 31.336 was obtained and rounded up to 32 (Adhikari, 2021). All participants were male and ranged in age from 19 to 24 years ($M = 21.28 \pm 1.75$). None had a history of significant injuries or illnesses that could impact their performance. Participants must actively compete in recognized tournaments and follow consistent training routines to qualify. As is common in regional Kabaddi training environments, all had experience in both offensive and defensive roles. However, specific positions like raider (attacker) or defender were not distinguished during data collection. Future research should consider grouping players by their role to better understand position-specific physical and performance demands.

Data collection

Data collection was carried out by measuring waist circumference with a measuring tape. In contrast, muscle mass, fat-free mass (FFM), and fat mass were measured using bioelectrical impedance analysis (BIA) with the InBody 270 brand made by InBody Co., Ltd., South Korea (Duren et al., 2008). The T agility test was used in this study to measure agility (Subramani, Perumal, and Velu, 2019; Labib Siena Ar Rasyid *et al.*, 2023). Researchers sought the help of kabaddi experts to conduct a kabaddi performance assessment. Kabaddi experts evaluate the Kabaddi players' playing performance by assigning points based on three factors, including their raiding ability. The evaluation also accounted for the following factors: We evaluated the athletes' catching ability and teamwork skills. Kabaddi experts rate each criterion on a scale of 1–10, with 10 representing the best performance (Singh, 2023).

Data analysis

Descriptive statistics used the mean, standard deviation, minimum, and maximum values of the research variables to describe the characteristics of the data. These variables included body composition (waist circumference, muscle mass, fat-free mass, and fat mass), agility, and Kabaddi performance. Furthermore, Pearson correlation analysis was used to identify the relationship between the independent variables, namely body composition and agility, with the dependent variable, Kabaddi performance. Then, multiple linear regression analysis was conducted to test the contribution of each independent variable to Kabaddi performance simultaneously. The results of linear regression were evaluated through the coefficient of determination (R-squared) value to determine how much the independent variables could explain the variance in the dependent variable. The ANOVA test was used to test the significance of the overall regression model by examining the F value and significance level (p-value). Finally, regression coefficient analysis was conducted to determine the specific contribution of each independent variable to Kabaddi performance. Variables with a p-value of less than 0.05 were considered to have a significant effect, with the direction and strength of the effect expressed through the regression coefficient value (β) and standard error. This approach provides a comprehensive understanding of the relationship between body composition, agility, and the performance of Kabaddi athletes.

Results

Table 1-3 will present the mean data, standard deviation, and minimum and maximum values of the variables in this study.

Table 1. *Descriptive Statistics of Anthropometric Parameters*

Variable	Mean±SD	Min	Max
Age (years)	21.28±1.75	19	24
Body weight (kg)	67.95±7.68	58	87
Body height (cm)	170±0.07	158	186

The 32 male Kabaddi athletes ranged in age from 19 to 24, with an average age of 21.28 ± 1.75 years. The average height was 170 cm, ranging from 158 to 186 cm, and the average weight was 67.95 ± 7.68 kg. These numbers show that young adult athletes in the competitive age range for high-performance Kabaddi comprised most of the sample.

Table 2. *Descriptive Statistics of Body Composition Data*

Variable	Mean±SD	Min	Max
Waist Circumference (cm)	0.83±0.06	0.72	0.93
Muscle Mass (kg)	21.77±2.32	16.4	26.3
Fat-Free Mass (kg)	45.28±3.49	40.2	53.7
Fat Mas (kg)	17.31±1.38	15.2	19.7

Table 2 shows the waist circumference, which ranged from 0.72 to 0.93 meters with a mean of 0.83 ± 0.06 meters. Muscle mass varied from 16.4 kg to 26.3 kg, averaging 21.77 ± 2.32 kg. Fat-free mass (FFM) had a mean of 45.28 ± 3.49 kg, indicating a consistent level of lean tissue among participants. Fat mass averaged 17.31 ± 1.38 kg and had a smaller range, suggesting that the athletes' fat tissue varied relatively little.

Table 3. *Descriptive Statistics of Agility and Kabaddi Performance Data*

Variable	Mean±SD	Min	Max
Waist Circumference (cm)	0.83±0.06	0.72	0.93
Muscle Mass (kg)	21.77±2.32	16.4	26.3
Fat-Free Mass (kg)	45.28±3.49	40.2	53.7
Fat Mas (kg)	17.31±1.38	15.2	19.7
Agility (s)	10.39±0.82	9.21	12.32
Kabaddi performance (raiding skills, catching skills, teamwork skills)	21.78±2.38	18	26

Table 3 presents the descriptive data on performance and agility. The fastest and slowest T-agility test times were 9.21 and 12.32 seconds, respectively, with an average of 10.39 ± 0.82 seconds. This range suggests there is room for performance improvement through targeted training, as it shows a moderate variation in agility levels among participants. Expert evaluators assessed the players' raiding, catching, and teamwork skills to determine their kabaddi performance, which resulted in a mean score of 21.78 ± 2.38, with scores ranging from 18 to 26. These scores indicate moderate-to-high proficiency across key kabaddi performance areas, reflecting relatively high consistency within the sample.

Table 4. *Pearson correlation of body composition and agility with kabaddi performance*

Variabel	Subvariabel	p (sig.)	R	R	R Square	Adjusted R Square	Std. Error of the Estimate
Body Composition	Waist Circumference	0.001*	0.749	0.976	0.953	0.944	0.56053
	Muscle Mass	0.001*	0.957				
	Fat-Free Mass	0.001*	0.937				
	Fat Mas	0.010*	0.512				
Agility		0.001*	-0.775				

**significant at p<0.05*

Table 4 uses Pearson correlation analysis to describe the correlation between body components, agility, and Kabaddi performance. Muscle mass showed the strongest correlation with Kabaddi performance (r=0.957, p=0.001), followed by fat-free mass (r=0.937, p=0.001) and waist circumference (r=0.749, p=0.001). Fat mass had a lower but significant correlation (r=0.512, p=0.010). In contrast, agility showed a significant negative correlation (r=-0.775, p=0.001), indicating that the faster the agility time, the better the Kabaddi performance of the players. Overall, the model's R-value of 0.953 suggests that combining these variables can explain 95.3% of the variance in Kabaddi performance.

Table 5. *Anova test result*

Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.
Kabaddi performance	167.300	5	33.460	106.494	0.000[b]

b. Predictors: (Constant), waist circumference, muscle mass, fat-free mass, fat mas, agility

The ANOVA test in Table 5 supports the overall significance of the model, with an F value of 106.494 and p = 0.000. These results indicate that the combination of the variables waist circumference, muscle mass, fat-free mass, fat mass, and agility contributes significantly to Kabaddi players' performance. This analysis confirms that body factors and agility are the main determinants of athlete success in this sport.

Table 6. *Coefficients of Kabaddi Performance*

Model	B	Std. Error	β	t	Sig.
(Constant)	4.701	3.628		1.296	0.206
Waist Circumference	1.822	2.341	0.050	0.778	0.443
Muscle Mass	0.571	0.121	0.544	4.723	0.000
Fat-Free Mass	0.191	0.079	0.281	2.408	0.023
Fat Mas	-0.005	0.104	-0.003	-0.045	0.964
Agility	-0.501	0.204	-0.173	-2.463	0.021

Dependent Variable: Kabaddi Performance

The coefficient analysis in Table 6 explains the individual contribution of each variable to Kabaddi performance. Increasing muscle mass directly improves kabaddi performance (B=0.571, p=0.000). Fat-free mass also has a significant positive contribution (B=0.191, p=0.023). In contrast, fat mass (B=-0.005, p=0.964) and waist circumference (B=1.822, p=0.443) have no significant effect on performance. The study reveals a significant negative contribution from agility (B=-0.501, p=0.021), suggesting a correlation between improved performance and excellent agility times. This study shows that muscle mass, fat-free mass, and agility are the main predictors of Kabaddi athlete performance, with muscle mass being the most influential variable.

Discussion

This study shows that muscle mass is a significant factor in Kabaddi players' performance. The relevance of substantial muscle mass ($\beta = 0.544$, $p < 0.001$) can be explained by the fact that this sport needs quick reactions for moves like jumping, pushing, and catching (Pramanick et al., 2022). Higher muscle mass allows athletes to produce greater power quickly, as noted by Kumar et al. (2023). In the context of Kabaddi, explosive power becomes especially important during the attacking phase, where players must quickly counter physical pressure from defenders (Sathshivam et al., 2023). Power, which is a combination of muscular strength and speed, allows athletes to produce force in a short period of time (Rusdiawan et al., 2024; Wismanadi et al., 2020).

In terms of raiding, strong power provides significant advantages (Dharod et al., 2020). Athletes possess the ability to swiftly engage with opponents and swiftly retreat to the safe zone prior to capture. In addition, explosive strength allows athletes to penetrate defenses and escape defenders' grips. This ability relies heavily on the core muscles, arms, and legs, which play a role in supporting rapid and dynamic movements (Singh, 2016). In terms of defense, power also plays an important role, especially when doing takedowns or stopping the opponent's movement (Pramanick et al., 2022). Athletes with explosive strength can provide enough force to stop the raider effectively, even when in a difficult position. High power also supports the ability to maintain body stability and utilize momentum, enabling athletes to maintain a solid defensive position (Ahmed, Saraswat, and Esht, 2022). Training that focuses on increasing muscle hypertrophy through methods such as resistance training and plyometrics is a highly recommended strategy to support this performance (Fatouros et al. 2000; Grgic, Schoenfeld, and Mikulic, 2021; Gunasekar and Balamurugan, 2021).

The significant correlation between fat-free mass (FFM) and Kabaddi performance ($r = 0.937$, $p = 0.001$) supports the argument that this component is not only relevant for power production but also metabolic efficiency. FFM reflects aerobic and anaerobic work capacity, which is essential for maintaining high intensity during 40 minutes of play. Additionally, increasing FFM may reduce the risk of premature fatigue, which is an important factor in long-duration competitions (Johnson and Ivarsson, 2017). Research has shown that protein-rich diets and creatine supplementation effectively increase FFM, and athlete development programs may prioritize these strategies (Hecht et al., 2023; Wax et al., 2021).

The study found a lower positive relationship ($r = 0.512$, $p = 0.010$) for fat mass, while waist circumference did not show a significant effect. This is consistent with previous studies, which stated that a high proportion of body fat can reduce movement efficiency due to excessive load (Damayanti & Adriani, 2021; Mohajan and Mohajan, 2023). Waist circumference as a proxy for abdominal fat distribution may be less relevant in determining direct Kabaddi performance. Therefore, coaches need to ensure that athlete training programs focus on increasing muscle mass and reducing body fat to improve the optimal muscle-fat ratio (Kurinami et al., 2021; Nishikori and Fujita, 2024).

Agility showed a significant negative correlation ($r = -0.775$, $p = 0.001$), indicating that the faster the time achieved in the T-agility agility test, the better the Kabaddi performance. In the game, the ability to move quickly

and precisely in a narrow space is crucial for avoiding defenders and catching opponents. Tamilselvan Scholar *et al.*, (2022) conveyed in their study that SAQ training, which focuses on improving agility, can also enhance the quality of kabaddi players. Agility training combining quick reactions and sudden direction changes is highly recommended. For instance, training methods such as ladder drills, zig-zag patterns, and SAQ training can enhance neuromuscular responses and quick reflexes, thereby supporting situational needs in the game of Kabaddi (Chandrakumar & Ramesh, 2015; Kurinami et al., 2021; Ravi and Divya, 2024; Tamilselvan Scholar et al., 2022). Compared to studies on other sports with similar characteristics, such as wrestling or rugby, the role of agility in Kabaddi is unique. For example, muscle mass has a more dominant influence in rugby than agility due to the greater need for physical contact (Dahiya & Kumar, 2023). This difference can be explored in understanding how each physical element has different significance based on the dynamics of a particular sport.

The results of this study highlight that not all components of body composition contribute significantly to performance. For example, fat mass and waist circumference showed minimal impact, possibly due to the complex interaction between body fat distribution and the specific demands of Kabaddi. Further in-depth research could identify whether there is an optimal threshold for a particular fat mass to support strength and endurance without compromising agility.

Conclusion

Agility and body composition significantly influence kabaddi performance, especially muscle mass and fat-free mass. Muscle mass supports explosive power, fat-free mass increases metabolic efficiency and work capacity, while agility allows for quick and precise movements in defense and attack. In contrast, fat mass and waist circumference have a lower or insignificant impact on performance. These findings emphasize the significance of enhancing muscle mass through resistance and plyometric training and enhancing agility through ladder drills. A protein-rich nutritional program and creatine supplementation also support fat-free mass increases. To optimize data-driven kabaddi training programs and support maximum performance at the international level, further research is necessary to understand the influence of player position and competition level.

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