

The relationship between body composition parameters, anaerobic power, and jumping performance in basketball players

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Abstract

Background and Study Aim Body composition, anaerobic power, and jumping performance are important factors for athletic performance. This study aimed to determine the relationship between body composition parameters and anaerobic power and jumping performance in basketball players.

Material and Methods Twelve male university students specializing in basketball (age: 20.83±2.21 years) participated voluntarily in the study. Body composition measurements and Wingate anaerobic power and countermovement jump (CMJ) tests were applied to the participants. This study was designed as a cross-sectional correlational study. The SPSS package program was used for statistical analysis of the data. The Shapiro-Wilk test was applied to assess the normality of the data. The data were found to follow a normal distribution. The Pearson correlation test was used to analyze relationships within the data.

Results According to the correlation test results, significant positive relationships were found between fat-free proportion and CMJ, peak power, mean power, and minimum power, while a significant negative relationship was found with the fatigue index. Significant positive relationships were also found between muscle proportion and CMJ, peak power, mean power, and minimum power, whereas a significant negative relationship was observed with the fatigue index. Similarly, significant negative relationships were found between fat proportion and CMJ, peak power, mean power, and minimum power, while a significant positive relationship was observed with the fatigue index. Significant positive relationships were identified between fluid proportion and CMJ, peak power, mean power, and minimum power. Significant negative relationships were found between basal metabolic rate (BMR) and peak power and minimum power, whereas a significant positive relationship was observed with the fatigue index. Lastly, significant negative relationships were found between visceral fat proportion and peak power, mean power, and minimum power, while a significant positive relationship was observed with the fatigue index.

Conclusions High fat mass negatively affects anaerobic power and jump performance, whereas higher muscle and fluid proportions improve performance. Strength training to increase lean body mass, maintaining fluid-electrolyte balance, and following a balanced nutrition program can positively impact athletic performance.

Keywords: body composition, anaerobic power, jumping, athletic performance, basketball

Introduction

Basketball is the second most popular sport in the world after football, played by two teams of five players who pass the ball within predetermined lines, block the opponent's moves, and attempt to score by throwing the ball into the opposing basket [1]. Basketball is not only a team sport but also a sport in which an athlete's individual characteristics are best demonstrated and developed, combining these attributes with game techniques and tactics. It is a game of fundamental movements that requires speed and high-performance competition. Additionally, basketball demands the ability to generate and sustain maximum energy output. This sport highlights that athletes are constantly competing in terms of speed, endurance, and overall performance [2].

The successful execution of sports performance relies on the effective development of an athlete's physiological and biomotor characteristics. From a physiological perspective, factors such as endurance, cardiovascular health, muscle mass, muscle strength, and energy metabolism play a crucial role. At the same time, biomotor skills such as balance, flexibility, speed, agility, and coordination significantly impact sports performance. Therefore, training programs generally aim to enhance an athlete's overall performance by focusing on these physiological and biomotor characteristics [3].

Body composition is generally defined by the proportion of muscle and fat in the body. The muscle-to-fat ratio plays a crucial role both in the selection of sports disciplines and in athletic performance. As body fat mass increases, lean mass decreases, which in turn reduces aerobic capacity

per kilogram of body weight. Consequently, the efficiency of oxidative energy metabolism for moving one kilogram of body mass declines. This indicates a significant relationship between lean body mass and anaerobic power [4].

Successful performance in basketball inherently depends on anaerobic components such as speed, agility, and vertical jump [5]. Since basketball primarily involves short bursts of intense effort, anaerobic power is a key factor in the sport. It is well established that anaerobic power is essential for executing tactical movements, shooting, jumping, blocking, passing, staging, and other technical actions in basketball [6, 7].

When analyzing the profiles of athletes across various sports, it becomes evident that possessing physical characteristics aligned with the specific demands of their sport, particularly in terms of body composition, can positively impact performance. However, to achieve their goals and attain high performance levels, athletes must develop adequate physical and physiological fitness specific to their discipline [8]. From this perspective, body composition is considered to play a significant role in anaerobic performance among basketball players and is also associated with their physical fitness profiles [9].

This study was conducted to examine the relationship between body composition parameters and anaerobic power as well as vertical jump performance in basketball players.

Materials and Methods

Participants

The minimum sample size for this study was determined using G*Power software (version 3.1.9.7) [10]. A robust power analysis was conducted based on the study's design parameters, specifically t-tests and a point-biserial correlation model. The analysis considered an α error probability of 0.05, a statistical power of 0.80 (1- β error probability), and an effect size of 0.50. The results indicated that a minimum of 10 participants was required to achieve the desired statistical power.

Twelve male university basketball players voluntarily participated in the study. The participants were students at Muş Alparslan University (Turkey) and had at least five years of basketball experience. The study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Muş Alparslan University Scientific Research and Publication Ethics Committee (approval date: 06.12.2024, approval number: 14-69).

Research Design

This study was designed as a cross-sectional correlational study. In this model, the goal is to determine whether there is a concurrent change

between two or more variables and to assess the strength of their relationship [11].

Before the study, each participant was provided with detailed information regarding the potential risks and discomforts associated with the study. A voluntary consent form was read and signed by all participants. Athletes with any chronic diseases, musculoskeletal injuries within the past year, or those requiring continuous medication were excluded from the study.

All participants were instructed to maintain their regular dietary habits and to refrain from consuming any ergogenic aids or stimulants during the experiment. Additionally, they were advised to avoid vigorous physical activity and caffeine intake for 24 hours prior to the measurements. All measurements were conducted between 16:00 and 18:00. Before the vertical jump and anaerobic power tests, the athletes completed a warm-up program consisting of 10 minutes of general warm-up exercises followed by 10 minutes of passing drills with a basketball. After the warm-up, they proceeded with the tests.

Data Collection Tools

Body Composition Measurements. The height of the athletes was measured in centimeters using a stadiometer (Holtain, Crymych, Pembrokeshire, UK) with an accuracy of ± 1 mm. Body weight and body composition were assessed using a Tanita MC 780 MA (Tanita Corporation, Tokyo, Japan) device. During the measurements, participants were instructed to stand barefoot on the metal surface of the device, grasp the designated handles with both hands, and keep their arms parallel to the body. Each measurement session lasted approximately 1–2 minutes per participant, and the results were printed directly from the device [12].

Countermovement Jump (CMJ). An electronic jumping mat (Fusion Sport Smart Jump, Australia) was used to measure the CMJ performance of the athletes. The test assessed the explosive power of the leg muscles based on maximal force. Participants performed a full vertical jump from a squat position with 90° knee flexion while keeping their hands on their waist. Each measurement was repeated three times, and the highest recorded value was used for analysis. A two-minute rest period was provided between trials [13].

Wingate Anaerobic Power Test (WAnT). Anaerobic performance was assessed using a bicycle ergometer (Monark 894E, Monark, Varberg, Sweden) connected to a computer and equipped with software specifically modified for the Wingate Anaerobic Power Test (WAnT).

Before the test, participants received detailed instructions regarding the procedure. A 4–5 minute warm-up protocol was then performed, which included 2–3 sprints lasting 4–8 seconds at a

workload of 60–70 W and a pedaling speed of 60–70 rpm. Following the warm-up, participants were given 3–5 minutes of passive rest.

After the warm-up and rest period, individual saddle and handlebar adjustments were made for each participant. The seat height was set so that when seated on the saddle, the participant’s knee would be in full extension when the pedal was at its lowest point. Participants’ feet were secured to the pedals using clips.

The test began once a resistance equivalent to 7.5% of each participant’s body weight was applied to the ergometer’s flywheel. To reach the target pedaling speed (130–150 rpm), participants were instructed to pedal at their maximal voluntary speed for 3–4 seconds without resistance, followed by 30 seconds of pedaling with resistance.

The fatigue index was calculated using the formula [14, 15]:

$$\text{Fatigue Index} = \frac{(\text{Peak Power} - \text{Minimum Power})}{\text{Peak Power}} \times 100$$

Statistical Analysis

The SPSS software package was used for statistical analysis. The Shapiro-Wilk test was applied to assess the normality of the data, which was found to follow a normal distribution. The Pearson correlation test was used to examine the relationship between body composition parameters and anaerobic power as well as jumping performance. The correlation coefficient

was interpreted using the following scale: trivial (< 0.10), small (0.10–0.29), moderate (0.30–0.49), large (0.50–0.69), very large (0.70–0.89), nearly perfect (0.90–0.99), and perfect (1) [16]. Linear regression analysis was conducted to identify which body composition variables with statistically significant correlations could serve as predictors for CMJ and WAnT outcomes. The results were reported using the coefficient of determination (R²). A Type I error level of 5% (p < 0.05) was considered statistically significant.

Results

Descriptive statistics for the general characteristics of the basketball players participating in the study are presented in Table 1. Descriptive statistics for body composition measurements, as well as jump and anaerobic power test results, are provided in Table 2.

The correlation results of the relationship between body composition parameters and jumping and anaerobic power in basketball players are presented in Table 3.

According to the correlation test results, significant positive relationships were found between fat-free proportion and CMJ, peak power, mean power, and minimum power, while a significant negative relationship was observed with the fatigue index. Similarly, significant positive relationships

Table 1. Descriptive Statistics of the General Characteristics of the Participants

General Characteristics	N	\bar{x}	SD
Age (years)	12	20.83	2.21
Height (cm)	12	183.42	7.46
Body Mass (kg)	12	80.43	12.94
BMI (kg/m ²)	12	23.80	2.62

Note. \bar{x} : Mean; SD: Standard Deviation; BMI: Body Mass Index.

Table 2. Descriptive statistics results of measurements and tests

Parameters	N	\bar{x}	SD	Shapiro-Wilk	
				Statistic	p
Fat-Free Proportion (%)	12	81.93	4.44	.974	.946
Muscle Proportion (%)	12	77.86	4.19	.974	.946
Fat Proportion (%)	12	18.07	4.44	.974	.946
Fluid Proportion (%)	12	56.98	3.85	.949	.617
Basal Metabolic Rate (kcal)	12	1.96	0.23	.942	.522
Visceral Fat Proportion (%)	12	3.25	2.00	.922	.307
CMJ (cm)	12	36.19	5.94	.992	1.000
Peak Power (W/kg)	12	11.61	0.99	.905	.184
Mean Power (W/kg)	12	8.10	0.44	.952	.671
Min. Power (W/kg)	12	4.66	0.79	.973	.938
Fatigue Index (%)	12	60.06	4.37	.899	.154

Note. \bar{x} : Mean; SD: Standard Deviation; p: Significance Value; CMJ: Countermovement Jump.

Table 3. Correlation results between body composition parameters and jumping and anaerobic power

Parameters		CMJ	Peak Power	Mean Power	Min. Power	Fatigue Index
Fat-free Proportion (%)	r	.629*	.760**	.641*	.770**	-.637*
	p	.028	.004	.025	.003	.026
	R ²	.395	.577	.411	.593	.406
Muscle Proportion (%)	r	.629*	.757**	.644*	.769**	-.638*
	p	.029	.004	.024	.003	.026
	R ²	.395	.573	.415	.592	.407
Fat Proportion (%)	r	-.628*	-.760**	-.641*	-.770**	.637*
	p	.029	.004	.025	.003	.026
	R ²	.395	.577	.411	.593	.406
Fluid Proportion (%)	r	.600*	.846**	.593*	.720**	-.499
	p	.039	.001	.042	.008	.098
	R ²	.360	.716	.352	.518	.249
Basal Metabolic Rate (kcal)	r	-.321	-.794**	-.484	-.729**	.581*
	p	.308	.002	.111	.007	.047
	R ²	.103	.630	.235	.532	.338
Visceral Fat Proportion (%)	r	-.453	-.791**	-.596*	-.851**	.760**
	p	.140	.002	.041	.000	.004
	R ²	.205	.626	.355	.725	.578

Note. *p<0.05; **p<0.01; CMJ: countermovement jump

were found between muscle proportion and CMJ, peak power, mean power, and minimum power, whereas a significant negative relationship was observed with the fatigue index.

Conversely, significant negative relationships were found between fat proportion and CMJ, peak power, mean power, and minimum power, while a significant positive relationship was observed with the fatigue index. Significant positive relationships were also identified between fluid proportion and CMJ, peak power, mean power, and minimum power.

Additionally, significant negative relationships were found between BMR and both peak power and minimum power, while a significant positive relationship was observed with the fatigue index. Lastly, significant negative relationships were identified between visceral fat proportion and peak power, mean power, and minimum power, whereas a significant positive relationship was observed with the fatigue index.

Discussion

This study analyzed the relationships between body composition parameters, anaerobic power, and jumping performance in basketball players. The findings revealed significant relationships between body composition parameters and anaerobic

power, supporting previous research indicating a strong association between body composition and anaerobic power in elite basketball players [17]. In basketball matches, anaerobic power serves as the primary source of movement and is closely linked to body weight, which can influence changes in anaerobic power among teams [18]. When Wingate test parameters were compared among basketball players, male athletes demonstrated higher values in absolute anaerobic power, explosive power, and absolute anaerobic capacity compared to female players [19]. Delestrat and Cohen [20] also emphasized that success factors in modern basketball are closely related to anaerobic power. The results of this study align with those reported in the existing literature.

Additionally, significant relationships were identified between body composition parameters and jumping performance. Previous research has found a highly significant relationship between fat-free mass and CMJ performance in high-performance young basketball players [21]. Silvestre et al. [22] reported a statistically significant relationship between body composition and vertical jump performance. Similarly, Kahraman and Arslan [23] observed that in U18 football players, vertical jump performance improved with increases in lean mass, muscle

mass, fluid mass, and BMR. Another study further confirmed that body composition significantly impacts vertical jump performance [24]. Successful basketball players have been shown to possess higher skeletal muscle mass and lower body fat percentages [25, 26]. Additionally, the relationship between BMI and jumping performance in young basketball players has been found to vary with age [27]. A strong positive correlation has been reported between fat-free mass and relative power, as well as between relative power and flight time [28].

Overall, the results of this study are consistent with findings in the existing literature, further supporting the importance of body composition in anaerobic power and jumping performance in basketball players.

In the current study, a very large positive correlation was found between visceral fat proportion and the fatigue index. Previous research has reported that athletes with a high tolerance to training loads tend to have lower visceral fat ratios [29]. Visceral fat is located within the inner abdominal cavity and surrounds vital organs, including the heart [30]. Its accumulation can influence the heart's response to exercise and negatively impact cardiovascular function [31]. In this context, athletes with higher visceral fat levels are more likely to experience fatigue.

In the current study, a significant negative correlation was found between BMR and both peak power and minimum power, while a significant positive correlation was observed with the fatigue index. Numerous factors influence BMR, with the strongest correlation being between an individual's lean mass and BMR [32]. It has been suggested that an increase in lean body mass leads to a higher BMR and, consequently, greater total energy expenditure [33].

However, the findings of this study indicate

that a higher BMR is associated with decreased power values and an increased fatigue index, which contradicts previous research. This discrepancy may be attributed to differences in the athlete profile and the sample size. Although the power analysis confirmed that the number of participants was sufficient for statistical analysis, the small sample size of twelve participants remains a limitation. Therefore, further studies with larger populations are necessary to validate these findings.

Limitations of the Study

This study has limitations, including a small sample size of twelve participants, which may reduce the generalizability of findings. The study focused only on male university basketball players, limiting its applicability to other athlete groups and competition levels. Future research with larger and more diverse samples is needed to confirm these findings and provide broader insights into body composition and performance.

Conclusions

High fat mass negatively impacts anaerobic power and jump performance, whereas higher muscle and fluid proportions contribute to improved performance. Strength training aimed at increasing lean body mass, maintaining fluid-electrolyte balance, and following a well-structured nutrition program can positively influence athletic performance. To optimize anaerobic power and jumping performance in basketball players, it is recommended to reduce body fat proportion and implement exercise and nutrition programs that support a balanced fat-free mass, muscle mass, and fluid proportion.

Conflict of interests

The authors declare that there is no conflict of interests.

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