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Correlation between Body Composition and the Performance of Vertical Jumps in Basketball Players

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ABSTRACT

Ribeiro BG, Mota HR, Sampaio-Jorge F, Morales AP, Leite TC. Correlation between Body Composition and the Performance of Vertical Jumps in Basketball Players. **JEP**online 2015;18(5):69-78. The purpose of this study was to correlate the variables of body composition with the performance of the vertical jump performed by professional basketball players. The subjects consisted of 11 male athletes from the National Basketball League First Division team. The athletes were between 25 and 37 yrs of age. Their height ranged from 175 to 205 cm with a body mass of 74.2 to 121.6 kg. For analysis of body composition, a BIA unit 450 Bio impedance Analyzer (Biodynamic Corp. USA) was used. The Vertical Jump was carried out with a Jump Platform, Optical System (Cefise, São Paulo). A strong negative correlation ($r = -0.8$) was found for the variable relative power ($W \cdot kg^{-1}$) and fat mass (%). A strong positive correlation ($r = 0.8$; $P < 0.05$) was found for the variable fat free mass (%) and relative power ($W \cdot kg^{-1}$), and a strong positive correlation ($r = 0.94$; $P < 0.05$) between the variable relative power ($W \cdot kg^{-1}$) and flight time (ms). We conclude that basketball players with a lower fat percentage and greater lean mass showed better performance in vertical jumps suggesting that body composition can be considered an indirect predictor of performance.

Key Words: Bioimpedance, Muscle power, Performance, Vertical jump

INTRODUCTION

Basketball is one of the most popular sports throughout the world. In Brazil we can report the achievement of world male and female championships, besides Pan-American and South American achievements in the adult category and various accomplishments in training categories as well as Olympic medals (19). Basketball can be considered a complex sport in which variations of actions occurs dynamically and continuously. Cormery et al. (5) defines basketball as a fast paced game of great speed with constant jumps and displacements both to attack and to defend. Hoffman et al. (10) reports that basketball represents all the main characteristics of muscle strength and speed of movement.

Obviously, then, while basketball athletes are strong, quick, and dynamically prepared to move and shoot the ball with great speed, power, and skill, what factor might limit their performance? There is the consideration of the basketball player's body weight. In fact, a high fat percentage may play a critical role in winning if it hinders the athlete's vertical jumps and speed of movement.

Nunes and colleagues (20) evaluated athletes of Brazilian women's basketball showed that the percentage of fat has negative correlation with the playing time, number of points, and recovered balls. In contrast, taller athletes with more lean muscle mass presented an advantage in most performance indicators. According to the authors, this result is expected, since athletes who have a higher percentage body fat (%BF) are not as fast or as powerful during the match compared to athletes with a lower %BF.

For athletes involved in sports that require consecutive jumps and sprints, such as basketball, low fat percentage can contribute to a performance improvement. Lohman et al. (15) propose that fat percentage of young male adults is within the population mean when found in a range of between 8% and 22%. A basketball player with a %BF above the population mean is likely to experience difficulty when competing with players who are >22%. Also, the high level of physical contact that occurs during the game is notorious. Consequently, strength and muscle power are crucial to high level performance in basketball. The ability to produce force and power seems to be optimized by an appropriate kinanthropometry profile (17).

The performance in the vertical jump (VJ) is a very important variable in the assessment of muscle power levels produced by the muscles of the lower limbs. Hence, it is common to use the VJ as an important predictor of performance in different sports that require jumping skills. In this case, for basketball, the VJ performance is directly related to the player's performance, showing to be a deciding factor in the efficient execution of basket pitches, dunks, blocked shots, and rebounds. Ackland et al. (1) reported that, on average, a basketball player jumps 46 ± 12 times per game. Hence, without question, success in basketball depends on the players' ability to jump vertically while combining shots with high level technical skill (7,11).

In an attempt to understand the factors that help coaches to monitor the evolution of the muscular power levels in athletes, the evaluation of body composition may be used with practical applicability and without the need of costly equipment. Thus, the aim of this study was to correlate the variables of body composition with the performance of VJ in professional basketball players.

METHODS

Subjects

The study was conducted with professional athletes from the Macaé Basketball National Basketball League (LNB) of the first division. The subjects consisted of 11 male athletes between 25 and 37 yrs of age, height 175 to 205 cm, and body mass of 74.2 to 121.6 kg. They were evaluated as healthy athletes with no history of musculoskeletal injury during the evaluation. All subjects were notified of the research procedures, requirements, benefits, and risks before providing written informed consent. The research protocol (692.573/2014) was approved by the Scientific and Ethics Committee of the Veiga de Almeida University, Brazil.

Procedures

The subjects' body weight, height, and body composition were determined in the morning before training by a single experienced evaluator. A stadiometer was used (Altuxata) to measure the subjects' height. Body weight was obtained using a medical scale TANITA UM-061 with the athletes wearing as little clothing as possible. Body composition was determined using a 450 Bioimpedance Analyzer (Biodynamics Corp, USA) while the subjects were in the supine position with the feet about 30 cm apart. Each subject remained in the supine position for ~10 min before the exam. The electrodes were positioned uniformly on the right foot and hand. One pair of electrodes was positioned distally on the basis of the third metatarsal and proximal between the medial and lateral malleoli, lying about 5 cm between them. The other pair of electrodes in his right hand, with the distal electrode at the base of the third metacarpal and proximal electrode coinciding with the tuber lister and with a distance of 5 cm between them (14).

The subjects were instructed to discontinue the use of diuretics at least 24 hrs prior to the test (16). They were also told not to consume food and beverages 4 hrs before testing. Interestingly, although there is general consensus that a subject should fast for 4 hrs and empty the bladder before the exam, it may not be a necessary procedure (8). After obtaining the necessary measurements, fat free mass, total body water, extra and intracellular water, and body cell mass were estimated.

Vertical Jump Performance

Performance in the VJ was assessed by the jump platform, Optical System (Cefise, São Paulo). The equipment contains a station bar and another receiver with optical sensors. They measure the contact time and the flight time between jumps. The bars are connected by cable to a computer. With the help of the software, "Jump System" (version 1.0, São Paulo, Brazil), flight time (ms), maximum attained height (cm), power absolute (W), and relative power ($W \cdot kg^{-1}$) were determined. The subjects performed the jumps starting from an upright position to an angle of approximately 90° at the knees, using help of upper limbs. A five maximum vertical jump protocol (5VJ) with a 5 sec interval between each jump was used. To alert and begin the test, a whistle was carried out by computer for every jump indicating the jump time performed by the athlete (18,23). All subjects were familiarized with the procedure.

Statistical Analyses

Descriptive analysis was performed on the subjects' (n = 11) anthropometrical characteristics, bioimpedance, and VJ data using mean and standard deviation (mean \pm SD) values to characterize the sample. Linear regression was also performed in order to know the mathematical function that best describes the phenomenon studied. The strength of the

correlations was based on the following: (a) weak correlation values between 0.3 and 0.5; (b) moderate correlation between 0.5 and 0.8; and (c) strong correlation between 0.8 and 1.

RESULTS

The subjects' anthropometrical characteristics, body composition, and vertical jump data are shown in Table 1.

Table 1. Descriptive Statistics (mean \pm SD) for the Basketball Players (n = 11).

Anthropometric Variables	
Age (yrs)	27.6 \pm 4.9
Height (cm)	190.2 \pm 10.1
Weight (kg)	89.6 \pm 13.8
BMI (kg·m⁻²)	24.7 \pm 2.4
Body Fat (%)	13.6 \pm 5.6
Body Fat (kg)	12.7 \pm 6.9
Fat Free Mass (%)	86.4 \pm 5.4
Fat Free Mass (kg)	76.4 \pm 9.0
Vertical Jump Variables	
5VJ (cm)	55.1 \pm 7.2
Flight Time (ms)	669.0 \pm 43.7
Absolute Power (W)	5308.6 \pm 676.4
Relative Power (W·kg⁻¹)	60.2 \pm 5.8

A strong negative correlation ($r = -0.8$) was found for fat mass (%) and relative power (W·kg⁻¹) (Figure 1).

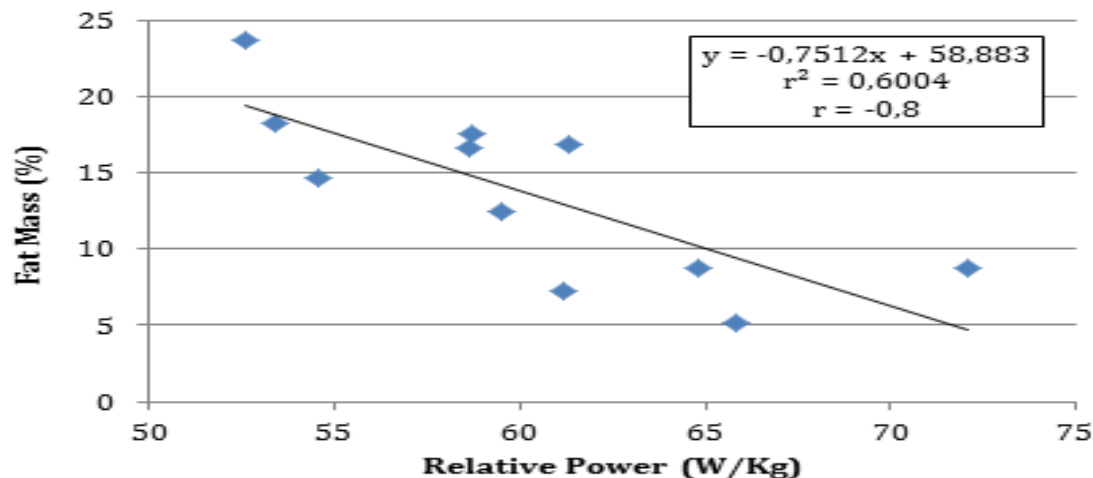


Figure 1. The Relationship between Relative Power (W·kg⁻¹) and Fat Mass (%).

A strong positive correlation ($r = 0.8$) was found for the fat free mass (%) and relative power ($\text{W}\cdot\text{kg}^{-1}$) (Figure 2).

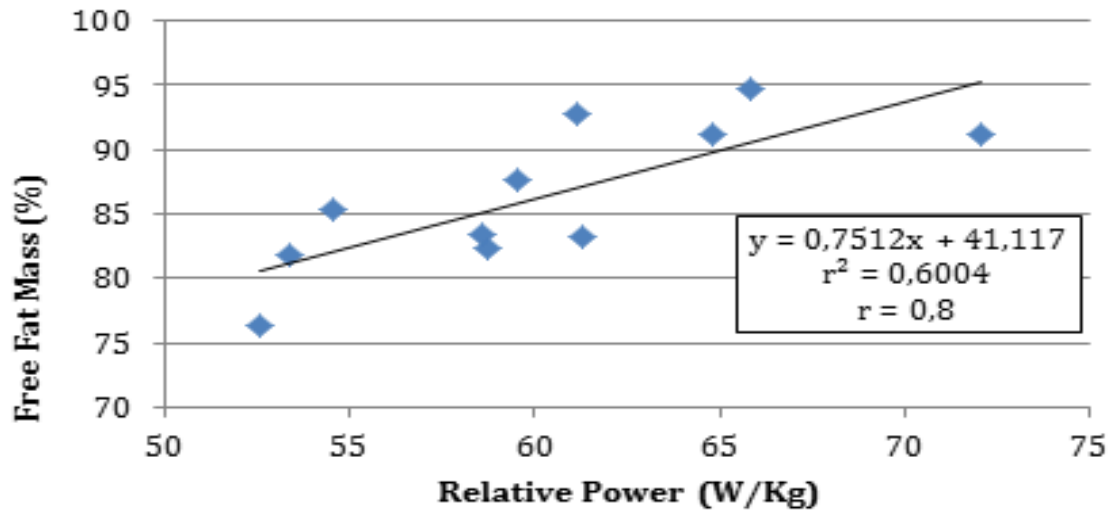


Figure 2. Relationship between Fat-Free Mass (%) and Relative Power ($\text{W}\cdot\text{kg}^{-1}$).

A strong positive correlation ($r = 0.94$) was found for relative power ($\text{W}\cdot\text{kg}^{-1}$) and flight time (ms) (Figure 3).

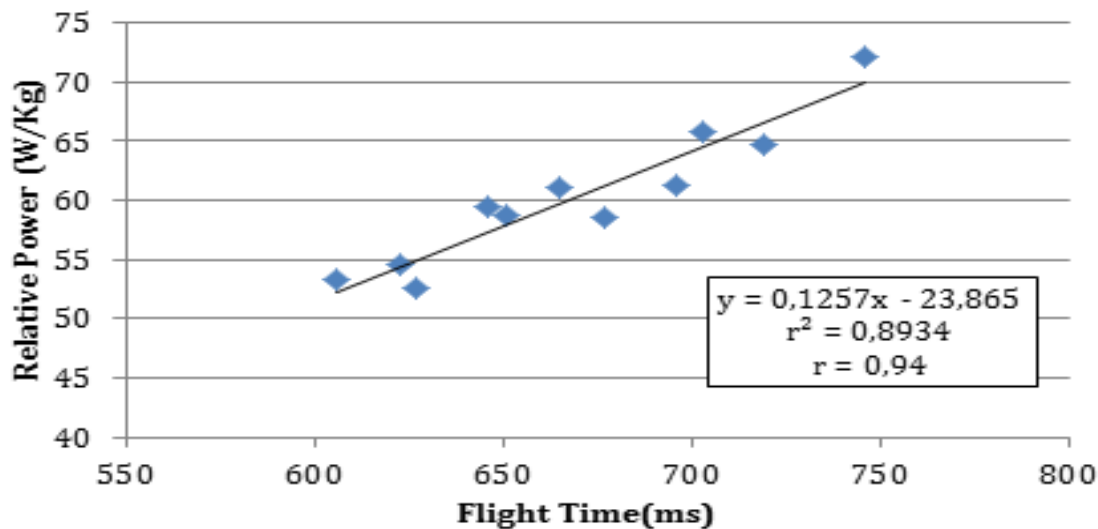


Figure 3. Relationship between the Flight Time (ms) and Relative Power ($\text{W}\cdot\text{kg}^{-1}$).

No statistically significant ($P > 0.05$) correlations were found in the subjects' flight time (ms) versus total body weight (kg), relative power ($\text{W}\cdot\text{kg}^{-1}$) versus lean mass (kg), BMI versus power (W), flight time (ms) versus fat mass (kg), and flight time (ms) versus total body weight (kg) (Table 2).

Table 2. Correlation Analyzed in this Study.

		r	R ²	Function	P
Relative power (W·kg ⁻¹)	vs. Flight fly (ms)	0.9	0.8934	y = 0.1257x – 23.865	<0.05
Relative power (W·kg ⁻¹)	vs. Free fat mass (%)	0.8	0.6004	y = 0.7512x + 41.117	<0.05
Relative power (W·kg ⁻¹)	vs. Fat mass (%)	-0.8	0.6004	y = -0.7512x + 58.883	<0.05
Relative power (W·kg ⁻¹)	vs. Fat mass (kg)	-0.7	0.5249	y = -0.8649x + 64.77	<0.05
Relative power (W·kg ⁻¹)	vs. Free fat mass (kg)	-0.08	0.0076	y = -0.1423x + 85.016	>0.05
Relative power (W·kg ⁻¹)	vs. IMC (kg·m ⁻²)	-0.6	0.4285	y = -0.2694x + 40.907	<0.05
Height (cm)	vs. Body mass (kg)	0.7	0.5345	y = 1.0021x – 101.05	<0.05
Flight fly (ms)	vs. Body mass (kg)	-0.2	0.0401	y = -0.0634x + 132.01	>0.05
Flight fly (ms)	vs. Fat mass (kg)	-0.5	0.2894	y = -0.0854x + 69.814	>0.05
Flight fly (ms)	vs. Fat mass (%)	-0.6	0.4060	y = -0.0821x + 68.599	<0.05
Absolute power (W)	vs. Free fat mass (kg)	0.9	0.7341	y = 0.012x + 12.765	<0.05
Absolute power (W)	vs. Body mass (kg)	0.8	0.5800	y = 0.0157x + 6.3428	<0.05
Absolute power (W)	vs. IMC (kg·m ⁻²)	0.3	0.1106	y = 0.0012x + 18.439	>0.05

DISCUSSION

This study found a strong negative correlation ($r = -0.8$) between the fat percentage variable (%) and relative power ($W \cdot kg^{-1}$) (Figure 1), and strong positive correlation ($r = 0.8$) between the subjects' fat free mass (%) and relative power ($W \cdot kg^{-1}$) (Figure 2), which is related to the higher relative power of the lower limbs and flight time and, consequently, the improvement of the basketball players' performance in the vertical jump. This study is in agreement with the findings of other authors in which the best performance in the VJ is in athletes with low body fat percentage, thus allowing for a great performance in game situations that require athletes to execute maximum vertical jumps one or more times during a match (3,21,25).

Relative power ($W \cdot kg^{-1}$) and flight time (ms) (Figure 3) showed a strong positive correlation ($r = 0.94$) for higher vertical jumps and longer flight times. The findings of Korkmaz and Karahan (12) regarding correlations of body composition variables and VJ of basketball athletes in three divisions of the national championship (1st division, 2nd division, and 3rd division) are in agreement with the present study. For example, they reported a negative correlation ($r = -0.51$) between relative power ($W \cdot kg^{-1}$) and fat percentage (%) and a positive correlation ($r = 0.95$) between relative power ($W \cdot kg^{-1}$) and height (cm) of the vertical jumps. Thus, the assessment of body composition emerges as an important tool to be used routinely by coaches and trainers throughout the season as an important indicator of performance in basketball.

The observations by Boone and Bourgois (4) are noteworthy, especially the height and body weight of the centers (206.6 ± 3.3 cm) and (111.2 ± 8.3 kg), respectively. But, when compared to the point guards (187.9 ± 3.3 cm, 83.2 ± 5.3 kg, and $11.2 \pm 2.8\%$, $P < 0.05$), the centers had a higher percentage of body fat ($15.2 \pm 4.0\%$). To be successful in basketball,

several fundamentals are necessary. One such fundamental is the low body fat percentage in basketball athletes.

Another fundamental to being successful in basketball is the rebound. In this case, a greater relative power that provides longer flight time should have a positive impact on the number of offensive rebounds and defensive moves achieved by any player. Nunes et al. (20) observed that the number of rebounds is also positively correlated with both height ($r = 0.61$, $P < 0.05$) and lean mass ($r = 0.45$, $P < 0.05$). The percentage of fat also had a weak correlation with playing time: (a) negative ($r = -0.51$); (b) number of points: negative ($r = -0.44$); (c) errors: Positive to ($r = 0.50$); and (d) recovered balls: a positive ($r = 0.51$) ($P < 0.05$). Thus, athletes with higher lean mass and height may have an edge in achieving rebounds and attacks. Also, the correlations between relative power and demonstrated fat percentage in this study (Figure 1) would not only favor the vertical jump, but also other performance indicators that are part of the game.

Similar to the findings in the present study, Smith and colleagues (24) concluded that in addition to good VJ technique the height of the VJ also depends on the athlete's strength and speed of the lower limbs. Recognizing the importance of the power of the lower limbs to the VJ, the positive relationship between the VJ and body composition, and the distribution of body composition may indicate athletes who have the physical condition to perform well in the game (20,26).

In agreement with the present study, which demonstrated a positive correlation between body composition and performance in the VJ, Angyan et al. (2), Hobbs (9), Hoffman and colleagues (10), and Kostopoulos (13) report that athletes with greater relative power, proper body composition, and performance in the VJ have more playing time and advantage over their opponents.

Driss et al. (6) assessed VJ and the maximum of relative power ($W \cdot kg^{-1}$) on a cycle ergometer in volleyball players. Their findings demonstrated a positive correlation ($r = 0.754$, $P < 0.001$) between relative power ($W \cdot kg^{-1}$) and SV. Pereira et al. (21) observed a moderate correlation (0.60-0.68) between power measurements obtained from the VJ height and peak power being the best correlation coefficients identified between the calculated power measurements with the height of the jump by Foot Switch. These authors demonstrate in their studies that relative power directly influences the performance in the VJ.

Just like in basketball, beach volleyball has the crucial point jump during the match. Riggs and Sheppard (22) evaluated 30 international standard beach volleyball athletes (14 male, 16 female) performing countermovement jumps (CMJ) and squat jumps (SJ) on a force platform. They noted the importance of muscle power of the lower limbs to the performance of height in the VJ. The strongest positive correlations with the female jump height were: (a) SJ, Relative Peak Power ($r = 0.90$); and (b) CMJ, Relative Average Power ($r = 0.67$). The strongest positive correlations with male jump height were: (a) SJ, Relative Peak Power ($r = 0.94$); and (b) Male CMJ, Relative Peak Power ($r = 0.83$). These correlations indicate that the athletes were able to sustain more time in flight (ms), corroborating the present study showing a strong positive correlation ($r = 0.94$) between relative power ($W \cdot kg^{-1}$) and flight time (ms) (Figure 3).

High-performance athletes in all sports need to explore their maximum performance in the game, and particularly basketball using the VJ to maximize the essentials that make up the sport. Monitoring of the multidisciplinary team is essential in the preparation and development of these athletes. Correlations made in this study enable the practice of this monitoring by BIA and VJ, since the variables correlated here as relative potency, fat percentage, fat free mass, and flight time are performance quality predictors of these athletes.

CONCLUSIONS

We conclude that the basketball players with a lower percentage of fat and greater lean muscle mass showed better performance in vertical jumps. Thus, the assessment of body composition emerges as an important tool to be used routinely throughout the season as an important indicator of performance in basketball.

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