THE RELATIONSHIP OF BODY COMPOSITION AND MOTOR ABILITIES OF FEMALE BASKETBALL PLAYERS

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***Abstract**: Success in the basketball game does not only require technical, tactical and psychological abilities, but also depends on body composition and motor abilities. The motor abilities that contribute most to success in basketball are explosive power, agility with and without the ball, and speed of cyclic or acyclic movements. Given that body composition and motor abilities are the basis for every sport, the aim of this study is to determine whether there is a connection between body composition and motor abilities of female basketball players. The sample of respondents consisted of female basketball players who play in the cadet league, with an average chronological age of 15.08 ± 0.94 years, who trained volleyball for an average of 5.93 ± 2.46 years. First, the subjects' body composition parameters were measured (body height, body mass, body mass index (BMI), fat percentage (BF), muscle percentage (Muscle%), followed by agility tests (T-test, Slalom, Slalom with ball), speed (5m, 10m and 20m sprint), and explosive power (Counter Movement Jump (CMJ), Counter Movement Jump With Arm Swing (CMJwas), Squat Jump (SJ)). The results showed that there is a relationship between the parameter BH with CMJ, CMJwas and SJ, then BW with CMJ, 20m and Slalom. Furthermore, BMI was correlated with CMJ and Slalom, and the parameters BF% and Muscle % with the motor abilities of explosive power, speed and agility. Based on the obtained results, it can be conclude that there is a statistically significant correlation between body composition parameters and motor abilities of female basketball players.*
***Key words**: speed, agility, explosive power, female basketball players, body composition*

INTRODUCTION

Basketball is a team sport played by two teams, each with five players, with the objective of scoring a goal in the opponent's basket and preventing the players of the opposing team from scoring or gaining possession of the ball, while adhering to and applying the rules of the game (Kočić & Berić, 2015). Women's basketball faced obstacles such as the isolation of physical education for female students and conservative rules of etiquette that did not allow girls to appear in shorts in front of the opposite sex. The main advocate of women's basketball was Senda Berenson, a physical education professor (Kočić & Berić, 2015).

Although the basic rules of basketball have remained practically the same to this day, the characteristics of the game itself, including speed, pace, energy, duration of attacks, number of shots made, points scored, sprints, jumps, duels, and fouls, are rapidly changing and are, in some ways, becoming more complex (Ljubojević, Bojanić, Krivokapić, & Nokić, 2020). In such conditions, success in basketball requires not only technical, tactical, and psychological skills but also depends on body composition and motor abilities (Ljubojević et al., 2020). According to Garcia-Gil et al. (2018), the motor abilities that most contribute to success in basketball are explosive strength, agility with and without the ball, and the speed of cyclic or acyclic movements.

The identification of specific body characteristics that can contribute to success in sports, as well as potential structural differences among athletes in different sports, has been a subject of great interest to sports scientists and coaches (Zaccagni et al., 1996; Duncan et al., 2006). Studies have determined that body composition affects motor abilities and have shown that differences in motor abilities in basketball can occur depending on body composition (Bajrić et al., 2011; Ribeiro et al., 2015; Rinaldo et al., 2020). It has been shown that changes in body composition leads to changes in physical performance and motor abilities, especially in speed, agility, and explosive strength. According to research (Gil et al., 2007), higher values of body mass, body mass index (BMI), and fat percentage have a negative impact on motor abilities, while lower values of these parameters result in improved sprint, acceleration, agility, and jumping abilities (Dodd & Newans, 2018).

Monitoring body composition and anthropometric characteristics is of great importance as they are prerequisites for improving motor abilities and achieving maximum success in sports (Mijalković, Mladenović, & Ilić, 2023). Given that body composition and motor abilities are fundamental to any sport, the aim of this study is to determine whether there is a connection between body composition and motor abilities in female basketball players.

METHODS

Sample of respondents

In this study, the participants were female basketball players who play in the cadet league, with an average chronological age of 15.08 ± 0.94 years, and who have been training basketball for an average of 5.93 ± 2.46 years. Prior to testing, all participants were informed about the protocol and gave their voluntary consent to participate in the research.

Testing procedures

The testing was conducted during training sessions in a sports hall in the evening, at an ideal temperature. First, a 15-minute warm-up was conducted, consisting of various movement exercises and exercises specific to a basketball training session to prepare the participants' bodies for testing.

Body height was measured with an anthropometer according to Martin's method GPM 101 (GPM GmbH Switzerland) with an accuracy of 0.1 cm. The participants stood with their backs against the anthropometer, fully extended with their heels together. The arm of the anthropometer was placed on the highest point of the crown, and body height was recorded (Madić, Nikolić, & Stojiljković, 2015). Body mass, body mass index (BMI), fat percentage, and muscle percentage were then measured using the Omron BF511 bioelectrical impedance device (Kyoto, Japan) with an accuracy of 0.1 kg. The participants stood barefoot on the device, holding the bioelectrical impedance handles at shoulder height. The reliability and validity of the Omron BF511 bioelectrical impedance were confirmed by Dehghan & Merchant (2008).

Explosive power was assessed using Optojump photoelectric cells (Microgate, Italy). The participants performed three static tests to evaluate explosive power: Squat Jump (SJ), Counter Movement Jump (CMJ), and Counter Movement Jump with Arm Swing (CMJwas). The SJ test is performed with hands fixed on the hips, starting from a half-squat position from which a maximum vertical jump is executed. The CMJ test is also performed with hands fixed on the hips; the participant moves from an upright position to a half-squat and then executes a maximum vertical jump. The CMJwas involves the same starting position as the CMJ, but the participants also use an arm swing (Madić et al., 2015). The reliability and validity of these tests were confirmed in the study by Markovic et al. (2004).

The running speed of the participants was tested using Witty photocell gates (Microgate, Italy) with an accuracy of 0.01 seconds (Madić et al., 2015). The participants were instructed to sprint from a high start position at the signal of the measurer, covering a set distance as quickly as possible. The Witty photocell gates were positioned at the start, 5 meters, 10 meters, and 20 meters, recording split times. The reliability and validity of these tests were confirmed in the study by Bishop et al. (2001).

To assess agility, Witty photocell gates (Microgate, Italy) were also used, positioned at the start, which was the target for all three tests: T-test, Slalom, and Slalom with Ball. In the T-test, cones were arranged in the shape of a T, with the distance from the start to the first cone being 10 meters, and the side cones being 5 meters apart. The participants had to sprint straight to the first cone, touch it, then move sideways with a shuffle step to the left cone, touch it, and then move in the same manner to the right cone, touch it, return to the middle cone, touch it, and finish by running backward to the start position (Madić et al., 2015). The Slalom test was set up over a total length of 11 meters. The distance between the start and the first cone was 1 meter, and the distance between each subsequent cone was 2 meters, totaling 6 cones. The participants were instructed to navigate the course as quickly as possible, running between the cones and turning 180° at the last cone to return to the start (Madić et al., 2015). The procedure for the Slalom with Ball test was the same as the Slalom test, with the addition of dribbling

a basketball while navigating the course. The reliability and validity of these tests were confirmed in the study by Sporis et al. (2010).

Statistical data analysis

For statistical data analysis, the IBM SPSS Statistics 20 software was used. Given that the normality of the data was confirmed by the Kolmogorov-Smirnov test, Pearson's correlation analysis was employed to determine the relationship between body composition and motor abilities. The correlation coefficient was represented as follows: trivial ($0 < r < 0.1$), small ($0.1 < r < 0.3$), moderate ($0.3 < r < 0.5$), large ($0.5 < r < 0.7$), very large ($0.7 < r < 0.9$), and nearly perfect ($0.9 < r < 1$).

RESULTS

Descriptive parameters of body composition and motor abilities, as well as the normality of data distribution, are presented in Table 1. The average height of the basketball players was 173.6 ± 5.96 cm, while the average weight was 63.18 ± 6.63 kg. The average body fat percentage was 23.97 ± 6.28%, and the average muscle mass percentage was 33.81 ± 2.46%. BMI was categorized according to data from the World Health Organization (WHO) for girls aged 2 to 19 years: less than the 5th percentile ≤16.3 (underweight); from the 5th to the 85th percentile 16.4 – 24.1 (normal weight); from the 85th to the 95th percentile 24.2 – 28.1 (overweight); and above the 95th percentile ≥28.2 (obese) (WHO, 2000). Given that the average BMI was 20.92 ± 1.69, it can be said that the basketball players were between the 5th and 85th percentiles, which would indicate that they were of normal body weight.

Table 1 Descriptive Statistics and Normality of Data Distribution

	Mean ± Std. Dev.	K-S *(Sig.)*
BH (cm)	173.6 ± 5.96	.652
BW (kg)	63,19 ± 6.63	.999
BMI	20.92 ± 1.69	.986
BF%	23.97 ± 6.28	.186
Muscle (%)	33.81 ± 2.46	.396
CMJ	27.72 ± 3.93	.978
CMJwas	31.09 ± 3.15	.562
SJ	26.94 ± 3.83	.432
5m	1.05 ± 0.07	.988
10m	1.87 ± 0.09	.835
20m	3.39 ± 0.19	.771
T test	11.92 ± 0.74	.984
Slalom	8.10 ± 1.40	.364
Slalom with ball	9.02 ± 0.52	.990

Legend: K-S (Sig.) – Kolmogorov-Smirnov test; BH (cm) – body height; BW (kg) – body weight; BMI – body mass index; BF – body fat percentage (%); Muscle (%) – muscle percentage; CMJ – Counter Movement Jump; CMJwas – Counter Movement Jump with Arm Swing; SJ – Squat Jump; 5m – 5-meter run; 10m – 10-meter run; 20m – 20-meter run; T-test – agility test; Slalom – agility test; Slalom with ball– agility test with ball.

A detailed presentation of the correlation between body composition and motor abilities of female basketball players is shown in Table 2.

Table 2 Results of the Pearson's correlation

	CMJ	CMJwas	SJ	5m	10m	20m	T-test	Slalom	Slalom with ball
BH (cm)	0.033*	0.048*	0.032*	0.391	0.439	0.851	0.644	0.839	0.864
	r-.550**	r -.518**	r -.554**	**r**.-.239	**r**.-.216	**r**-.056	**r**. 130	**r**. 057	**r.** 038
BW (kg)	0.000*	0.177	0.632	0.436	0.636	0.026*	0.862	0.018*	0.176
	r -.798**	**r**-.317	**r** .193	**r** .288	**r**-.133	**r**-.443**	**r** -.049	**r** .508**	**r**-.369
BMI	0.024*	0.899	0.321	0.786	0.959	0.704	0.529	0.042*	0.395
	r -.578**	**r**-.036	**r**-.275	**r**-.077	**r** .015	**r** .107	**r**-177	**r** -.531**	**r** .237
BF%	0.008*	0.627	0.260	0.003*	0.578	0.252	0.680	0.402	0.038*
	r -.659**	**r**-.137	**r**-.311	**r** .607**	**r** .356	**r** .316	**r**-.116	**r** .234	**r** -.523**
Muscle (%)	0.012*	0.504	0.024*	0.940	0.043*	0.373	0.046*	0.351	0.174
	r -.631**	**r** .187	**r**-.579**	**r** .091	**r** -.513**	**r**-.248	**r** -.498**	**r**-.259	**r** .475

Legend**:** BH (cm) – body height; BW (kg) – body weight; BMI – body mass index; BF – percentage of body fat (%); Muscle (%) - muscle percentage; CMJ – jump with preparation; CMJwas – jump with arm swing preparation; SJ - squat jump; 5m – running for 5 meters; 10m – running for 10 meters; 20m – running for 20 meters; T-test – test for assessing agility; Slalom – agility assessment test; Slalom with ball - a test for assessing agility. ****r < 0.01; *p < 0.05**

Based on Pearson's correlation analysis, shown in Table 2, it can be concluded that there is a statistically significant correlation between body composition parameters and motor abilities of female basketball players in the area of explosive power, speed and agility.

DISCUSSION

Given that in the majority of papers so far, the respondents were male, this research dealt with the question of whether there is a connection between the body composition and the motor abilities of female basketball players. There is clear scientific evidence of a strong connection between body composition and motor performance in athletes. In addition to high technical and tactical skills, it is necessary to monitor motor abilities and body composition for success in basketball. It has been established that when there is a change in body composition, there is also a change in motor abilities in basketball, and thus body composition is related to motor abilities (Bajrić et al., 2011; Ribeiro et al., 2015; Rinaldo et al. ., 2020).

When it comes to body height and mass, body height had a statistically significant correlation with explosive strength results in the CMJ, CMJwas, SJ tests (r = -.550; r = -.518; r = -.554). More precisely, it could be concluded that taller female basketball players passed all three explosiveness tests more efficiently than shorter ones. Pelemiš et al. (2021) obtained similar results in their study. Body mass had a statistically significant correlation with the results of the 20 m sprint, Slalom and CMJ (r = -.443; r = .508; r = -.798). This result of the analysis stems from the fact that female basketball players had a much higher percentage of muscle than the percentage of fat in their body. Furthermore, it could be suggested that female basketball players who had a higher body mass also had a higher percentage of muscle, and therefore better results in these tests of motor abilities. Namely, similar results were obtained in the study by Gryko, Adamczyk, & Kopiczko (2022) with a similar sample of respondents. Therefore, when there is a higher percentage of muscle mass in the body, it could be concluded that then a higher value of body mass would have a favorable effect on motor abilities. In order to be more successful on the court, female basketball players should reduce their body fat percentage and increase their muscle mass. Body mass index (BMI) had a statistically significant correlation with parameters of explosive strength and agility, more precisely in the CMJ and Slalom tests (r = -.578; r = -.531). The results of the relationship between BMI and CMJ were also obtained in the study by Nikolaidis et al. (2015), while the relationship between BMI and Slalom was established by Mladenović et al. (2021) obtained in their study. However, it should be emphasized that the BMI parameter is not a reliable indicator, because it cannot distinguish muscle mass from fat mass. When it comes to the parameter of fat percentage (BF%), the obtained results show a statistically significant correlation with explosive power (CMJ; r = -.659), speed (5m; r = .607)

and agility (ball slalom; r = -.523). The muscle mass percentage parameter (Muscle %) was also correlated with explosive power (CMJ, r = -.637; SJ, r = -.579), speed (10 m, r = -.513) and agility (T-test, r = -.498). Such obtained results of correlation between BF% and Muscle % with motor abilities in basketball were also obtained in many previous studies (Scanlan et al., 2014; Rinaldo et al., 2020; Mladenović et al., 2021).

A study limitation of this study could be reflected in the small number of respondents. Also, the testing was done immediately after the end of the competitive season. Therefore, it is assumed that, if the testing was done before the start of the competition season, the motor abilities of the subjects could be at a more enviable level.

CONCLUSION

Depending on the sport, motor abilities and body composition have an impact on the success of the sports performance itself. In this study, it was concluded that there is a significant correlation between body composition and motor abilities of female basketball players. The BH parameter had a statistically significant association with CMJ, CMJwas and SJ, while the BW parameter had a statistically significant association with the 20m sprint, Slalom and CMJ. Furthermore, the parameter BMI had a significant association with CMJ and Slalom, while both parameters BF% and Muscle % were statistically associated with explosive power, agility and speed. In the end, it could be concluded that for a more effective training process in the multi-year training cycle of female basketball players, it is necessary to continuously monitor the body composition in addition to the development of motor abilities.

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ПОВЕЗАНОСТ ТЕЛЕСНОГ САСТАВА И МОТОРИЧКИХ СПОСОБНОСТИ КОШАРКАШИЦА

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Сажетак: *Успех у кошаркашкој игри не захтева само техничке, тактичке и психолошке вештине, већ зависи и од телесног састава и моторичких способности. Моторичке способности које највише доприносе успеху у кошарци су експлозивна снага, агилност са и без лопте и брзина цикличних или ацикличних покрета. С обзиром да су телесни састав и моторичке способности основ за сваки спорт, циљ ове студије је утврдити да ли постоји повезаност између телесног састава и моторичких способности кошаркашица. Узорак испитаника чиниле су кошаркашице које играју кадетску лигу, просечне хронолошке старости 15.08 ± 0.94 година, које су тренирале одбојку у просеку 5.93 ± 2.46 година. Најпре су испитаницама измерени параметри телесног састава (телесна висина, телесна маса, индекс телесне масе (BMI), проценат масти (BF%), проценат мишића (Muscle%), а затим су уследили тестови агилности (T-test, Slalom, Slalom sa loptom), брзине (спринт на 5m, 10m и 20m), и екплозивне снаге (Counter Movement Jump (CMJ), Counter Movement Jump With Arm Swing (CMJwas), Squat Jump (SJ)).Резултати су показали да постоји повезаност између параметра BH са CMJ, CMJwas и SJ, затим BW са CMJ, 20m и Slalom. Даље, BMI је корелисан са CMJ и Slalom, а параметри BF% и Muscle % са моторичким способностима експлозивне снаге, брзине и агилношћи. На основу добијених резултата може се закључити да постоје статистички значајна корелација између параметара телесног састава и моторичких способности кошаркашица.*

Кључне речи: *брзина, агилност, експлозивна снага, кошаркашице, телесни састав*