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ORIGINAL ARTICLE

Evaluation of explosive strength in U16 girls basketball players in Tirana of Albania

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ABSTRACT

Basketball requires repeatedly different movements while taking brief breaks. Players must continuously improve the components of strength, speed, etc. Aim is to document the explosive strength through the test (CMJ) of U16 female basketball players under the impact of a recommended training of 11 weeks. Method: No. 60 young girls' basketball players will be randomly selected into experimental group (EX-No.31 aged 16.2 ± 0.4) and Control (CO-No.29 years 16.1 ± 0.3). Both groups were subjected to anthropometric measurements: Body Height (BH), Body Weight (BW) and Test countermovement jump (CMJ) before and after the implementation of the training program with the Experimental group for 11 weeks with three blocks of exercises; Instruments used to GRFP "*Leonardo*" offer objective diagnosis power, force, jump height and efficiency. Results: Descriptive statistics resulted in BH (EX -168.2 cm) and BH (CO- 169.2 cm), BW (EX 60.7 kg) and BW (CO 62.2 kg) and CMJ improvements were observed on EX-JH 0.03m after training while the control group had a decrease in JH of 0.01m. Conclusion: Coaches should standardize their work in terms of improving both explosive strength and monitoring short- and long-term training. These data are of great interest for the basketball training process.

Keywords: Performance analysis, Basketball, Jump, Training, Explosive.

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INTRODUCTION

One of the most well-liked team sports in the world is basketball. This game moves quickly and requires both technical and tactical skills. Players must repeatedly sprint, leap, and change direction while taking brief breaks, but basketball players must have the necessary physiological (such as body mass and height) and physical (such as strength, speed, and anaerobic and aerobic capacity) attributes due to the sport's complexity in order to perform at their best (Čabarkapa et al., 2020; Mihajlovic et al., 2023). The countermovement vertical jump (CMJ) is one of the most often used basketball moves, included into both offensive (such as passing and shooting) and defensive (such as blocking and rebounding) actions (Ziv & Lidor, 2009). According to earlier studies, basketball players make about 1,000 movements during a game, of which 45 are jumping motions (Ziv & Lidor, 2009; McInnes et al., 1995). CMJ is frequently included in basketball players' physical performance evaluations as a non-invasive and time-efficient method of assessing athletes' lower-body neuromuscular performance characteristics, as it is a crucial talent linked to a team's success (Ishida et al., 2021; Taylor et al., 2012). Variety of technologies have been employed for the CMJ study (e.g., accelerometers, motion capture systems, jump mats), force plate systems are regarded as a standard or criterion measure because of their comprehensive assessment of the jumping motion, in particular, the force plate systems give practitioners a wealth of kinetic and kinematic data throughout both the concentric (CON) and eccentric (ECC) phases of CMJ in addition to outcome metrics (such as jump height) (Cabarkapa. D et al., 2023; D. V. Cabarkapa et al., 2024). Compared to their female counterparts, male athletes showed noticeably stronger CMJ performance (i.e., larger vertical jump height) according to the same experiment (Mancha-Triguero et al., 2021).

A cohort of basketball players competing at the U14, U16, and U18 levels showed notable increases in CMJ performance as players became older (Mancha-Triguero et al., 2021), in particular, the U18 basketball players' vertical jump heights were significantly higher than those of the U14 group (males: 32.6 ± 6.4 vs. 38.2 ± 11.3 cm, females: 25.5 ± 3.9 vs. 33.2 ± 5.9 cm). Ages (U14 vs. U18), sexes (male vs. female), positions (guards vs. forwards), playing time (starters vs. non-starters), and competition levels (elite vs. collegiate) all significantly affect CMJ performance, according to prior studies (Mancha-Triguero et al., 2021; Silva et al., 2011). Moreover, considering the position-specific differences, in a recently published investigation from (D. Cabarkapa, Philipp, et al., 2023) revealed that centres for a male professional basketball team had considerably higher mean power, braking impulse, and ECC mean force in absolute terms; however, these disparities vanished when the athletes' body mass was taken into account, in contrast, centres showed considerably lower relative CON mean and peak force during the CON phase of the CMJ compared to guards, while there were no differences in the absolute terms. Although these results provide insightful information on basketball players' CMJ performance, there is still a dearth of data pertaining to female athletes. Future studies are therefore necessary to gain a deeper understanding of the neuromuscular performance traits of female basketball players, particularly across various age groups. Although these results provide insightful information on basketball players' CMJ performance, there is still a dearth of data pertaining to female athletes.

Future studies are therefore necessary to gain a deeper understanding of the neuromuscular performance traits of female basketball players, particularly across various age groups. Moreover, body composition is a significant component that is directly linked to excellent basketball play (Correas-Gómez et al., 2023; Zaric et al., 2020). Strength and conditioning specialists can use this information to create more customized training regimens that take into account the aforementioned differences as well as morphological and physiological development (Zaric et al., 2020). Research indicates that basketball players who achieve greater success tend to have lower body fat percentages and higher skeletal muscle mass. This helps them perform explosive

moves more effectively during the game, such as vertical jumps and/or change of direction, and lower their risk of overuse injuries (Zaric et al., 2020; Visnes & Bahr, 2012). For instance, females often have a larger body fat percentage than males due to biological necessities (such as pregnancy) and differences in hormone profiles (Karastergiou et al., 2012; Sansone et al., 2022). Additionally, when athletes age, their bodies experience notable morphological changes over the course of time (Sansone et al., 2022). It is important to acknowledge that variations in body composition are contingent upon factors such as gender (male versus female), competition level (international versus regional), and age (young versus professional athletes) (Sansone et al., 2022).

Innovative technology enables us to evaluate the sports performance of athletes as is the platform; Leonardo® Ground Force Reaction Plate (GRFP-e Novotec Medical, Pforzheim, Germany) which is used to assess ground reaction forces (GRF) during movements (Leonardo 2010). The most important factor to be controlled is the vertical jump technique, which directly affects the results of the height jump, Pmax and Fmax in the test. The height in take-off is affected directly by vertical velocity at take-off and by the centre of gravity. Based on second Newton's law, considering only vertical component, the forces that act at a body in z-direction are: the reaction ground force FZ (t) and the body weight mg, which are related to the vertical acceleration as follows: $\Sigma F_Z = m\frac{dv}{dt} = F_Z(t)-mg$. Solving the above equation $for\frac{dv}{dt}$ and integrating the results as a time function, the velocity of the mass center in takeoff.

Coaches should have a standardization of their work in terms of improving fitness and sports performance as well as monitoring short-term and long-term training which is enabled by GRFP. Therefore, it is essential that players and trainers regularly track changes in anthropometric traits and consider the variations in body composition associated to sex, particularly in the younger athlete population.

The goal of the current investigation was to document the anthropometric and explosive strength through the test (CMJ) characteristics of U16 female basketball players under the impact of a recommended training of 11 weeks in the first phase of the 2024-2025 sports season. This was done in light of the significance of CMJ and body composition assessments for basketball players as well as the paucity of sports science research focusing on female basketball players in Albania.

MATERIALS AND METHODS

Participants

Subjects will be about 60 young girls' basketball players aged 16 years old, a number which is a fairly good sample considering the total number of basketball players of this age who are active in the Albanian National Championship. Subjects will be randomly selected and will be divided into Experimental (EX-N.31) and Control (CO-N.29) groups. Girl's participants playing basketball (BB) voluntarily participated in this study had a minimum of 5 years of experience in their respective sport and trained 5 times a week for 90 minutes in Tirana, Albania.

Procedure

Prior to the study, all players were informed about the procedures, and their consent was obtained. The study was approved by the Ethics Council of the Sports University of Tirana, Albania. Written informed consent was obtained from all participants and their parents and coaches (for participants under 18 years old), in accordance with the ethical standards of the Declaration of Helsinki. Prior to the study, all players were informed about the procedures, and their consent was obtained. The study was approved by the Ethics

Council of the Sports University of Tirana, Albania. Written informed consent was obtained from all participants and their parents and coaches (for participants under 18 years old), in accordance with the ethical standards of the Declaration of Helsinki. Timeline: The study was conducted from September to December 2024. Both groups included in the study were subjected to anthropometric measurements: Body Height (BH), Body Weight (BW). Timeline: The study was conducted from September to December 2024.

Test protocol

Basketball girls' players were tested in physical performance of protocol test countermovement jump (CMJ), designed to evaluate specific aspect related to our research objective. Players were tested before and after the implementation of the training program with the Experimental group for 11 weeks, while the Control group developed the training according to the method of their coach. Tests were conducted in the "*Laboratory of Biomechanics*" at the Sports University of Tirana. The subjects performed a warm-up of 10 min before the beginning of the tests.

Countermovement Jump (CMJ)

The players begin the test from an upright position and gain momentum by flexing the lower limbs to 90º degrees with the hands placed on the hips (waist). This test evaluates explosive strength with the reuse of elastic energy. The best value obtained from three repeated tests was considered as the final result for analysis. CMJ test was conducted before and after 11 weeks in both studied groups.

Instruments

The measurements were recorded in force plate to GRFP "*Leonardo Mechonagraphy*" protocol (Leonardo 2010). GRFP offers objective diagnosis of individual performance (power) and movement analysis, measurement, diagnosis, and evaluation of Force, Speed, Power, Work, Energy stored, as well as various throws. Leonardo® has the characteristic of evaluating both right and left limbs in comparison to detect unilateral deficiencies.

Intervention

A new and innovative model in experimental group was practiced in 3 sessions (Monday and Wednesday) for 11 weeks, to improve the performance of basketball players. While the control group trained according to their trainer's method. Program is built by (Cissik, 2014) with three blocks of exercises:

First block (weeks 1-3) will contain exercises for strength, power. Exercises; Strength: (back squats: 3×12-15@60-70%, lunges: 3×12-15 on each leg, Romanian deadlifts: 3×12-15, reverse hyperextensions: 3×12-15). Power: vertical jump: 10x, standing long jump: 10x.

Second block (weeks 4-8) is more difficult, more intense and more complicated than the previous block. Exercises; Strength (back squats: 3×8-12@70-80%, Romanian Deadlifts: 3×8-12, Bench Press: 3×8-12@70-80%, Bent-Over Rows: 3×8-12, Military Press: 3×8-12). Power: (Box Jumps (jump onto box, step down): 5-10x, Hurdle Hops (jump over mini-hurdles): 3×10 yards).

Third block (weeks 9-11) requires the strongest, most intense training. It is extremely important that we have completed the other two blocks before starting this one. Exercises; Strength: (Back Squats: 3×4-8@80-90%, Romanian Deadlifts: 3×4-8, Bench Press: 3×4-8@80-90%, Bent-Over Rows: 3×4-8, Military Press: 3×4-8. Power: (Box Jumps (jump onto box, step down): 5-10x, Hurdle Hops (jump over mini hurdles): 3×10 yards).

Statistical analysis

In this paper, the SSPS package program was used for data analysis. All data are reported as means ± standard deviation unless stated otherwise. Descriptive statistics for all players were calculated for age, height, weight, jump height, force, power and efficiency. Statistical analyses were performed with an a priori significance level of $p < .05$.

RESULTS

Table 1 gives descriptive statistics of the anthropometric parameters of girls' basketball players 16 years old, but also the data obtained before and after the 11-week training program in the CMJ explosive strength performance test. Subjects EX group N.31 aged mean (16.2 ± 0.4) years old, while the group CO N.29 aged mean (16.1 ± 0.3) years old. Anthropometric characteristics: BH (EX -168.2 cm) and BH (CO- 169.2 cm), BW (EX 60.7 kg) and BW (CO 62.2 kg).

Table 1. Descriptive statistics of parameters of girls' basketball players before and after 11-week.

			Age (yr)	BH (cm)	BW (kg)	JH (m)	Fmax (kn)	Pmax (w\kg)	EFFI (%)
EX	Before	**M**	**16.2**	**168.2**	**61.42**	**0.40**	**2.37**	**43.37**	**98.4**
		SD	0.4	7.56	12.89	0.044	0.353	5.874	9.287
		Max.	17	181	101.3	0.47	3.02	53.47	112
		Min.	16	154	45.4	0.31	2	33.64	77
	After	**M**	**16.2**	**168.2**	**61.72**	**0.43**	**2.53**	**47.88**	**102.8**
		SD	0.4	7.56	11.56	0.045	0.349	5.643	5.316
		Max.	17	181	97	0.5	3.44	55.83	111
		Min.	16	154	48.1	0.35	2.07	35.64	92
CO	Before	**M**	**16.1**	**169.2**	**62.2**	**0.36**	**2.26**	**39.7**	**93.4**
		SD	0.3	2.89	6.29	0.029	0.295	3.253	10.998
		Max.	17	173	74	0.42	3.16	45.32	103
		Min.	16	161	48	0.31	1.8	35.31	63
	After	**M**	**16.1**	**169.2**	**63.02**	**0.35**	**2.17**	**38.46**	**91.2**
		SD	0.3	2.89	7.45	0.031	0.198	3.865	11.983
		Max.	17	173	77.4	0.42	2.64	43.32	101
		Min.	16	161	46.1	0.3	1.82	32.28	62

*Note. *Statistical significance at the p < .05 level. (M-Mean: EX-Experiment: CO-Control: BH-Body Height: BW-Body Weight: JH-Jump Height: Fmax-Force: Pmax-Power: EFFI- Efficiency: SD-Standard Deviation).*

Table 1 also generates descriptive statistics for the variables obtained during the two measurements of the CMJ test before and after. The results obtained from these measurements are used to describe the characteristics of players in jump height, strength, power and efficiency.

DISCUSSION

Few studies have been found on the development of explosive strength in female basketball players (before-during-end of the sports season), especially in Albania. Explosive strength through CMJ has been evaluated more in volleyball players, as a sport more specific in the use of vertical jump. Development of test batteries at the level of elite female basketball in Albania would enable the longitudinal evaluation of players and the establishment of minimum physical standards for playing positions and levels of competition ((Lleshi & Kurti, 2024), for more, there is a need for updated research that includes studies on female players, given the

growing interest in women's basketball. Lleshi (2019) has shown a positive correlation between explosive strength and speed on the field in a comparison between volleyball and basketball players, where players with a higher CMJ tend to have high court speeds and better manoeuvrability. Our results indicate that there are significant differences in jumping performance between EX and CO players. It would be pertinent for future investigations to determine how the game effects CMJ performance among players. Furthermore, the jump heights reported by our investigation are smaller than the average jump heights reported by (Kipp et al., 2020) (CMJ Height: 62.4 ± 5.4 cm). There is speculation that arm swing could potentially counteract lower extremity actions and mask lower limb force asymmetries, both countermovement jump (CMJ) variations (with and without arm swing) offer reliable insights into inter-limb asymmetries (Heishman et al., 2019). Previous research has reported that lower body strength of basketball players decreases during the playing season despite efforts to maintenance fitness, strength and power (Murr et al., 2023).

Findings of the present study suggest that girl basketball players were able to improvements and maintenance of performance with regards to various CMJ force-time in jump height after 11 weeks of commanded training. Regarding lower-body explosive strength, improvements were observed on EX in test CMJ after training experiment in JH 0.03m while the control group had a decrease in JH of 0.01m. In elite Brazilian female basketball players, authors observed a significant increase of nearly 3.5 cm in the SJ performance, followed by 12 weeks of basketball training periodization (Nunes et al., 2014), but no data was displayed regarding the CMJ. According to the literature, there is a trend of greater gains in stretch-shortening cycle movements of the CMJ than in concentric-only movements of the SJ, particularly after implementing specific strength and conditioning programs (Stojanović et al., 2016). Study conducted to evaluate the effects of 8 weeks of plyometric training on the jump ability in female basketball players aged 20. 9 ± 2.4 years reported greater improvements in the SJ (+10.4%) than in the CMJ (+3.6%) (Cherni et al., 2020). Although different trends have been observed concerning the SJ and CMJ performance, the literature advocates that optimizing the players' jumping ability might be decisive for competition (Banda et al., 2019; Cherni et al., 2020). Spiteri et al. (2013) monitored changes in CMJ jump height following training sessions and competitions in female basketball athletes. We can say that a player's ability to maintain high outputs during a CMJ may be of importance throughout training and competition. We think that physiological impacts following conditioning sessions that focus on different physical aims, may help coaches periodize conditioning sessions more effectively.

CONCLUSION

Our results show that this training model was effective for U16 basketball players. Coaches should standardize their work in terms of improving both explosive strength and monitoring short- and long-term training. Data presented can serve as a reference point for CMJ outputs at the level of basketball competition in female. These data are of great interest for the basketball training process. Due to the limited investigations conducted in female basketball in Tirana of Albania, future studies are still needed, especially regarding the longitudinal effects of training prescription according to player positions.

AUTHOR CONTRIBUTIONS

Migena Plasa led the study design in collaboration with Ferdinand Mara. M. Plasa designed the new training model for girls on experimental group was practiced in 3 sessions (Monday and Wednesday) for 11 weeks, to improve the performance of basketball players. The implementation of this training was carried out by the two authors. The protocol tests were conducted under the control of M. Plasa in accordance with all the design rules of the methodology to achieve the processing of the results and conclusions of this study. Both

authors have read and approved the final version of the manuscript and agree to be responsible for all aspects of the work.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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