STUDIA UBB EDUCATIO ARTIS GYMN., LXX, 1, 2025, pp. 93-103
(RECOMMENDED CITATION)
DOI:10.24193/subbeag.70(1).08

Increasing the Explosive Power Through Plyometric Training in Athletes Under 18 Years Old

Cristian SANTA[1*], Andrei CRISAN[2], Onela SANTA[3]

Article history: Received 2024 December 20; Revised 2025 February 12; Accepted 2025 March 03; Available online 2025.03.30; Available print 2025.05.30

ABSTRACT. Increasing the explosive power through plyometric training is one of the most important aspects of sports, especially in team sports, regardless of players' training level. Explosive power represents muscles' ability to generate force quickly and is crucial for achieving a high vertical jump. Plyometric training, also known as jump training or explosive power training, is an essential method in preparing athletes to improve their physical performance, particularly in sports that require explosive strength and speed. **Methods:** The testing was conducted on two junior groups from the "School Sports Club" and BC 2B Sports Zalău, from the sports disciplines of volleyball and basketball, over a period of two and a half months. **Objective:** The objective of this study are to prove that the explosive power can be increased through plyometric training in athletes under 18 years old. **Results:** The analysis of the results was conducted after doing both the initial tests and the final tests for test 1, Sargent Jump Test from standing position, and test 2, Sargent Jump Test with full approach. Both teams completed the same tests, and the results were as follows: Volleyball team's first test showed increasing numbers - from 1 centimeters to 11 centimeters; Basketball team's first test showed increasing numbers- from 1 centimeters to 16 centimeters; Voleyball team's second test showed improved numbers - from 3 centimeters to 15 centimeters; Basketball team's second test showed improved numbers - from 0 centimeters to 19 centimeters. **Conclusion:** In summary, based on the results, this research has shown that plyometric training is an essential and efficient method for increasing the explosive power, developing the vertical jump and boosting the physical

[1] Faculty of Physical Education and Sport, Babeş-Bolyai University, Cluj-Napoca, Romania
[2] Faculty of Physical Education and Sport, Babeş-Bolyai University, Cluj-Napoca, Romania
[3] Onisifor Ghibu High School, Cluj-Napoca, Romania
* Corresponding author: cristian.santa@yahoo.com

performance of young athletes. Some subjects achieved good results in both tests, while others excelled in only one; however, the average results indicated that the hypothesis was confirmed.

Keyword: *Basketball, Voleyball, Sargent Jump Test, Explosive Power, Vertical Jump*

REZUMAT. ***Dezvoltarea detentei prin intermediul antrenamentelor de pliometrie la grupele de sportivi de sub 18 ani.*** Dezvoltarea detentei prin antrenamente pliometrice este unul dintre cele mai importante aspecte ale sportului, mai ales în sporturile de echipă, indiferent de nivelul de pregătire al jucătorilor. Forţa explozivă reprezintă capacitatea muşchilor de a genera forţă rapid şi este crucială pentru obţinerea unei sărituri verticale cât mai înalte. Antrenamentul pliometric, cunoscut şi sub numele de antrenament cu sărituri, este o metodă esenţială în pregătirea sportivilor pentru a-şi îmbunătăţi performanţele fizice, în special în sporturile care necesită forţă explozivă şi viteză. **Metode:** Testarea a fost realizată pe două grupe de juniori de la "Clubul Sportiv Şcolar" şi BC 2B Sports Zalău, din disciplinele sportive volei şi baschet, pe o perioadă de două luni şi jumătate. **Obiective:** Obiectivul acestui studiu este de a demonstra că detenta se poate dezvolta prin intermediul antrenamentelor de pliometrie la grupele de sportivi de sub 18 ani. **Rezultate:** Analiza rezultatelor a fost efectuată după finalizarea ambelor teste iniţiale şi finale pentru testul 1, Sargent Jump Test de pe loc şi testul 2, Sargent Jump Test din deplasare. Ambele echipe au efectuat aceleaşi teste, iar rezultatele au fost următoarele: Echipa de volei a prezentat o creştere a valorilor la primul test - de la 1 centimetru la 11 centimetri; Echipa de baschet a prezentat o creştere a valorilor la primul test - de la 1 centimetru la 16 centimetri. Echipa de volei a prezentat o îmbunătăţire a valorilor la al doilea test - de la 3 centimetri la 15 centimetri. **Concluzie**: Pe baza rezultatelor obţinute, cercetarea realizată a demonstrat că antrenamentul pliometric este o metodă esenţială şi eficientă pentru creşterea detentei şi îmbunătăţirea performanţei fizice generale a tinerilor sportivi. Rezultatele testelor pot varia, unii subiecţi obţinând rezultate bune la ambele teste, în timp ce alţii au excelat doar la unul; cu toate acestea, valorile medii crescute au indicat confirmarea ipotezei.

Cuvinte-cheie: *Baschet, Volei, Sargent Jump Test, Detentă, Săritură în înălţime*

INTRODUCTION

The increase of explosive power through plyometric training has been, is, and will remain one of the most important aspects of sports, particularly in team sports, regardless of the players' skill levels. Explosive strength and

explosive power are essential in most sports. Explosive power is the ability of muscles to generate force quickly and is crucial for achieving high vertical jumps. Bompa (2001) emphasizes the importance of explosive power in vertical jump development, stating that training focused on explosive power can significantly enhance this motor skill (Bompa, 2001). Recent studies also support this, showing that plyometric and explosive power exercises can significantly improve vertical jump performance (Markovic & Mikulic, 2010). Vertical jump is the ability of an athlete to elevate their center of gravity during a jump through a rapid and explosive action of the lower limb muscles (Dragnea & Teodorescu-Mate, 2002). The coordination between the muscles involved in jumping and the execution technique influences vertical jump performance. A well-developed jumping technique can maximize the efficiency of the force generated by the muscles (Alexe, 1993).

Research published in the Journal of Sports Medicine highlights the benefits of plyometric exercises on the elastic properties of muscles and jump performance (Komi & Gollhofer, 1997). Different types of plyometric exercises can have varying effects on sports performance. For example, vertical jumps and throwing exercises can be more effective for improving high jumps, while long jumps and sprint exercises can be more beneficial for developing lateral speed and agility (Moran et al., 2018).

The duration and intensity of a plyometric training program play a crucial role in muscular and neuromuscular adaptations. A training program of 6-12 weeks, with sessions 2-3 times per week, has been proven effective in improving sports performance (Ramirez-Campillo et al., 2014). The effectiveness of plyometric training can vary depending on the age and fitness level of the athletes. Young athletes and those with advanced fitness levels tend to benefit more from intense plyometric training compared to novice or older athletes (Lloyd et al., 2012).

Another study indicates that developing vertical jump through predominantly plyometric exercises increases musculo-tendinous stiffness, allowing better utilization of elastic energy stored during the amortization phase of the jump (Wilson et al., 1991). Plyometric training, also known as jump training or explosive power training, is an essential method in preparing athletes to improve their physical performance, especially in sports requiring explosive strength and speed. This type of training is based on exercises that combine speed and strength to develop muscular power (Chu, 1998).

These trainings replaced general physical preparation workouts, which were conducted twice a week. Thus, on Tuesdays and Thursdays, the volleyball and basketball subjects followed these experimental training plans with plyometric exercises. After the training period, tests were performed to determine if the

experiment was successful. For testing the subjects (initial and final) regarding vertical jump, we chose the following tests: the Sargent Jump Test from a standing position and the Sargent Jump Test with a run-up.

OBJECTIVE

The objective of this study is to demonstrate that the explosive power can be increased through plyometric training in athlete groups under 18 years old. The tests used involved vertical jumps from a standing position and with a run-up. By analyzing the results following plyometric training, we could assert with confidence that our desired objective is achieved in the case of significant improvements.

METHODS

The testing was conducted on two junior groups from the School Sports Club and BC 2B Sports Zalău, representing the sports disciplines of volleyball and basketball, over a period of two and a half months. A total of 20 male athletes participated in the study, 10 volleyball players from the School Sports Club and 10 basketball players from BC 2B Sports Zalău, aged between 13 and 15 years. All participants were registered athletes actively involved in local and regional competitions. The study was carried out in the training facilities of the two clubs, located in the city of Zalău. Participation in the study was based on informed consent provided by the athletes' parents.

The Vertec is a device for measuring vertical jump. It can be mobile or attached to an installation. The device provides rods at different heights, which athletes touch through jumping, providing real measurements of the subjects' vertical jump. Both tests will be conducted using the Vertec device. The first test will be the Sargent Jump Test from a standing position, conducted as follows: the athlete stands under the Vertec device and raises their arm as high as possible, reaching for the marked rods to determine the starting height, measured from the fingertips to the ground. After measuring, from a standing position, the athlete performs a maximal vertical jump, trying to touch the highest rod possible. The difference between the last rod touched by the subject and the starting height measured represents the subject's vertical jump (from a standing position). Each subject will have three attempts, with the best value being recorded. The second test will be the Sargent Jump Test with a run-up. The starting height measurements from the first test remain valid. This test will be conducted as

follows: from a standing position, face-to-face with the Vertec device and 5 meters away from it, the athlete performs a maximal vertical jump with a run-up, trying to touch the highest rod possible. Given the differences in sport techniques, the volleyball team will perform the run-up with the specific volleyball approach, while the basketball team can choose between jumping off both lower limbs or off one lower limb, both options being present in basketball. This choice was left open as the athletes already had a preferred technique they used more often, with which they obtained better results. The difference between the last rod touched by the subject and the starting height measured represents the subject's vertical jump (with a run-up). As with the other test, subjects will have three attempts, with the best value being recorded.

Fig. 1. Standing Sargent Jump Test
1.a. initial standing; **1.b.** standing jump; **1.c.** jump.

Fig. 2. Sargent Jump Test with approach
2.a. approach; **2.b.** jump take off; **2.c**. jump.

RESULTS

Table 1. Initial and final test results of the volleyball team

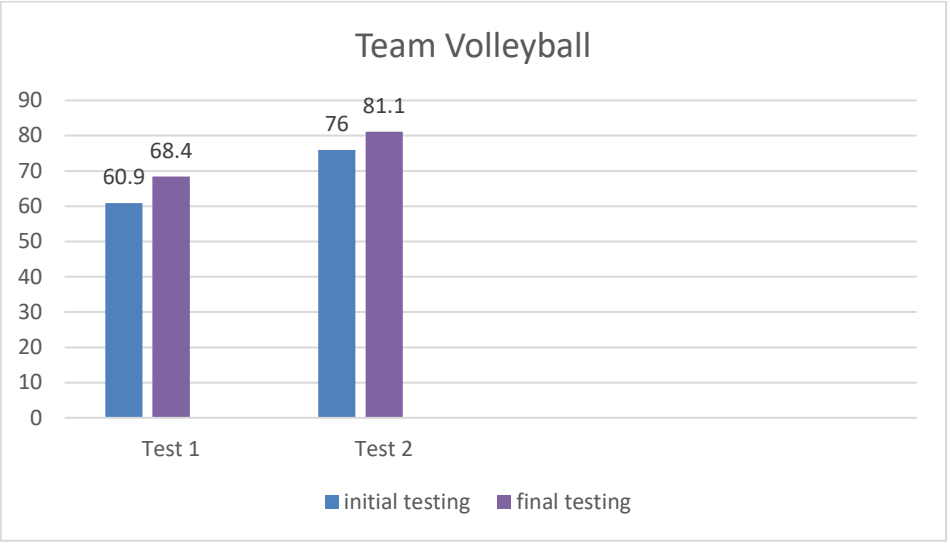
Name	Test No. 1 (cm)		Test No. 2 (cm)	
	T.i.	T.f.	T.i.	T.f.
A.S.	50	56	63	75
A.D.	57	62	70	74
C.R.	49	60	61	64
C.D.	56	62	76	80
C.G.	61	70	80	86
D.B.	60	67	83	89

Name	Test No. 1 (cm)		Test No. 2 (cm)	
	T.i.	T.f.	T.i.	T.f.
E.C.	75	82	93	95
F.C.	79	85	90	92
G.E.	64	75	75	82
G.D.	58	65	69	74
Mean	**60,9**	**68,4**	**76**	**81,1**
SD	**9,68**	**9,56**	**10,7**	**9,61**

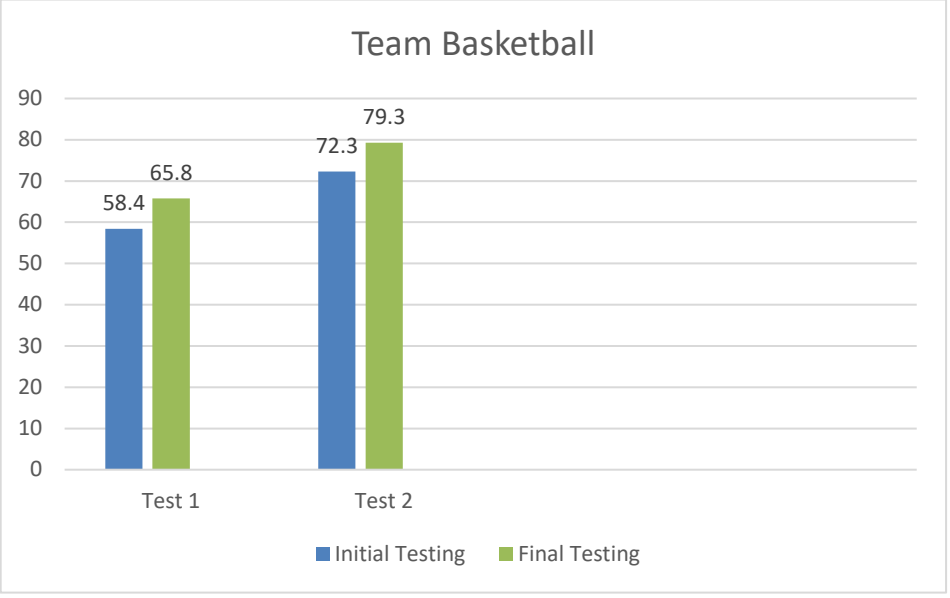
Table 2. Initial and final test results of the basketball team

Name	Test No. 1 (cm)		Test No 2 (cm)	
	T.i.	T.f.	T.i.	T.f.
I.R.	61	67	70	79
L.T.	40	55	60	65
L.S.	78	84	89	93
L.D.	49	62	66	76
M.S.	68	69	76	76
M.A.	59	70	74	79
P.C.	60	61	72	72
P.A.	48	56	67	77
R.I.	50	56	63	75
R.C.	71	78	86	92
Mean	**58,4**	**65,8**	**72,3**	**79,3**
SD	**11,82**	**9,75**	**9,39**	**8,46**

The results demonstrated a significant improvement in the physical performance of the athletes. For the volleyball team, the arithmetic mean of the initial and final values of Test No. 1 increased from 60.9 cm to 68.4 cm, and for Test No. 2 from 76 cm to 81.1 cm. Similarly, the basketball team recorded an increase from 58.4 cm to 65.8 cm for Test No.1 and from 72.3 cm to 79.3 cm for Test No. 2.



Graph No 1. Initial and final results of volleyball team in the standing Sargent Jump Test



Graph No. 2. Initial and final results of the basketball team in the Sargent Jump Test with approach.

DISCUSSION

The data collected in this study support the effectiveness of plyometric training in enhancing lower-body explosive strength in athletes under the age of 18. These findings are consistent with prior research by Markovic and Mikulic (2010), who demonstrated that structured plyometric programs lead to several beneficial neuromuscular adaptations. These include: Improved muscle activation and coordination between muscle groups; Enhanced mechanical efficiency of the muscle–tendon system; Increased effectiveness of the stretch-shortening cycle (SSC), which is critical for explosive actions such as jumping and sprinting

The improvements observed in vertical jump performance among both volleyball and basketball players in this study reflect these underlying physiological changes. The rise in jump height following the training intervention aligns with mechanisms previously identified in older or more experienced athletic populations, indicating that similar responses can be expected in adolescents.

To evaluate athlete progress, this study utilized the My Jump smartphone application. The accuracy and reliability of this tool were previously examined by Yingling et al. (2018), who compared it to the more traditional Vertec system. Given these findings, the My Jump app can be considered a viable and accessible tool for field-based assessment, particularly in settings where advanced equipment is not available. However, to maintain consistency in repeated measurements, it is recommended that the same tool be used throughout the assessment period, rather than switching between devices.

Although average group performance improved, the degree of progress varied considerably between individuals. This variation highlights the need for more personalized approaches to training. Markovic and Mikulic (2010) emphasize that an athlete's response to plyometric exercises depends on several factors, including:

- Initial fitness level and physical maturity
- Training load and intensity
- Prior experience with explosive training methods

These differences reinforce the importance of tailoring training programs to the individual rather than relying solely on uniform routines. Personalized adjustments may help optimize gains while reducing the risk of overtraining or injury.

CONCLUSIONS

Based on test results, both plyometric and explosive strength exercises can significantly improve vertical squat performance. This experiment aimed to investigate the effectiveness of plyometric training in the increasing of the explosive power of athletes under 18 years of age, through studies conducted on two teams, volleyball and basketball. Throughout the research, initial and final data were collected to evaluate the athletes' progress, utilizing various methods and specific plyometric training techniques. This process allowed for a detailed analysis of how plyometric exercises influence the jumping ability and explosive power of young athletes. For the volleyball team, the arithmetic mean of the initial and final values of Test No. 1 increased from 60.9 cm to 68.4 cm, and for Test No. 2 from 76 cm to 81.1 cm. Similarly, the basketball team recorded an increase from 58.4 cm to 65.8 cm for Test N0.1 and from 72.3 cm to 79.3 cm for Test No. 2. These improvements confirm the effectiveness of plyometric training in the increasing of the explosive power and support the research hypothesis. The detailed analysis of the athletes' progress also revealed that the improvements were not uniform, with significant individual variations, highlighting the importance of tailoring training programs to the specific needs of each athlete. Therefore, considering the obtained results, we can conclude that the objective was achieved, with significant improvements observed. This indicates that the explosive power can be increased through plyometric training in athletes under 18 years of age.

REFERENCES

Alexe, N. (1993). *Teoria şi metodica antrenamentului sportiv*. Editura Didactică şi Pedagogică.

Bompa, T. (2001). *Periodizarea: Teoria şi metodologia antrenamentului sportiv*. Editura EX PONTO.

Chu, D. A. (1998). *Jumping into plyometrics*. Human Kinetics.

Dragnea, A., & Teodorescu-Mate, S. (2002). *Teoria sportului*. Editura FEST.

Komi, P. V., & Gollhofer, A. (1997). Stretch reflex can have an important role in force enhancement during SSC-exercise. *Journal of Applied Biomechanics, 13*(4), 451–460. https://doi.org/10.1123/jab.13.4.451

Lloyd, R. S., Oliver, J. L., Hughes, M. G., & Williams, C. A. (2012). The effects of 4-weeks of plyometric training on reactive strength index and leg stiffness in male youths. *Journal of Strength and Conditioning Research, 26*(10), 2812–2819.

Markovic, G., & Mikulic, P. (2010). Neuromuscular and performance adaptations to lower-extremity plyometric training. *Sports Medicine, 40*(10), 859–895. https://doi.org/10.2165/11318370-000000000-00000

Moran, J., Sandercock, G. R., Ramírez-Campillo, R., Meylan, C., Collison, J., & Parry, D. A. (2018). Age-related variation in male youth athletes' countermovement jump following plyometric training. *Journal of Strength and Conditioning Research, 32*(2), 567–576.

Ramírez-Campillo, R., Meylan, C., Alvarez, C., Henríquez-Olguín, C., Martínez, C., Cañas-Jamett, R., & Izquierdo, M. (2014). Effects of in-season low-volume high-intensity plyometric training on explosive actions and endurance of young soccer players. *Journal of Strength and Conditioning Research, 28*(5), 1335–1342.

Wilson, G. J., Newton, R. U., Murphy, A. J., & Humphries, B. J. (1991). The optimal training load for the development of dynamic athletic performance. *Medicine and Science in Sports and Exercise, 25*(11), 1279–1286.

Yingling, V. R., Castro, D. A., Duong, J. T., Malpartida, F. J., Usher, J. R., & Ong, J. (2018). The reliability of vertical jump tests between the Vertec and My Jump phone application. *Journal of Physical Therapy Science, 30*(9), 1341–1346. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5912202/