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The Effect of Box Jumping and Barrier Jumping Exercises on Jump Height

Muhammad Zen Almunawar[1], Siti Ayu Risma Putri[2], Jujur Gunawan Manullang[3*], Grace Kharisma Tambunan[4]

[1,2,3,4]Department of Master Study Program In Physical Education,
Universitas PGRI Palembang, Indonesia
*Corresponding Author: Jujur Gunawan Manullang, e-mail:
jujurgm@univpgripalembang.ac.id

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Abstract

Study purpose. This study was conducted in response to insufficient lower leg muscle explosiveness observed in volleyball extracurricular students at State High School 1 Madang Suku III, which adversely affected their jumping performance during gameplay.

Materials and methods. A quantitative experimental approach was employed using a two-group pretest–posttest design. Statistical analyses were performed using paired-sample t-tests to examine within-group differences and independent-sample t-tests to compare the effects between groups.

Results. The findings revealed that the Jump to Box training method significantly enhanced lower limb muscle explosive power ($t = 56.564$, $p < 0.05$). Likewise, the Barrier Hops training method demonstrated a statistically significant improvement ($t = 59.088$, $p < 0.05$). However, the results of the independent-sample t-test indicated no statistically significant difference in effectiveness between the two training interventions ($p = 0.704$).

Conclusions. These findings suggest that both Jump to Box and Barrier Hops exercises are equally effective in improving lower limb explosive power among volleyball extracurricular participants.

Keywords: Jump To Box; Barrier Hops; Jump Height; Explosiveness; Leg Muscles; Volleyball

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Introduction

Volleyball is a team sport characterized by a series of explosive activities of short duration, such as serving, ball reception, set-up, smash, sprint, and jumping (Lidor et al., 2021; Lidor & Arnon, 2022; Catal et al., 2025). In volleyball, the level of physical fitness of the players is mainly related to the results achieved by the team in the competition (Chuang et al., 2022; Henrique et al., 2022). Volleyball is considered an anaerobic sport (Laudio et al., 2009; Catal et al., 2025). Specifically, the anaerobic component of volleyball lies in the execution of short actions such as jumps, blocks, and smashes. Especially in the attacking phase of the game (Costa et al., 2017), the sport demands a high level of technical precision as well as optimal

physical capacity to achieve maximum performance (Isanto et al., 2017). Vertical jumping movements and explosive activities have a very dominant role during the game, comparable to their contribution to other sports such as football and basketball (Bartol et al., 2022; Huang & Huang, 2024). Therefore, volleyball athletes are required not only to master advanced technical skills, but also to have sufficient muscle strength to perform dynamic movements efficiently (Derek et al., 2025; Miguel et al., 2025).

The ability to jump vertically is a fundamental component in volleyball technique, especially in smash and block skills (Danang Dwi Prasetyo, 2025). In general, there are two main approaches to improving jumping ability, namely through improving motor movement patterns with repetition and optimization of techniques, and through stimulating short muscle stretching cycles using plyometric exercises (Zghal et al., 2019; Liu et al., 2024). The repetition of motor patterns contributes to improved intra and inter-muscle coordination, which ultimately results in greater force production (Mariola et al., 2025; Granacher et al., 2021). In addition to the motor aspect, the process of learning movements that are oriented towards increasing strength also plays a role in the development of cognitive structures, thereby strengthening neuromuscular adaptation (Sutapa et al., 2021; Hill et al., 2024). Thus, the mastery of optimal movement patterns not only increases the physical capacity of athletes, but also supports the efficiency of movement execution during the game.

Plyometric exercises are the most widely applied method to improve vertical jumping ability. This training approach focuses on developing explosiveness and muscle strength, and has been shown to have a positive impact on various components of physical ability, such as strength, agility, and sprint speed (Alim et al., 2024; Ma et al., 2025; Pratama, 2024). These characteristics make plyometric training particularly relevant for sports that demand high explosiveness, including volleyball, where vertical jump height is often used as a key indicator of athlete performance (Pedley et al., 2017). Among the various forms of plyometric exercise, vertical fall jumps and barrier jumps are among the most commonly used to improve neuromuscular readiness as well as the explosiveness of the lower leg muscles (Novita et al., 2022; Febrianta et al., 2025). Studies comparing boxing and jumping exercises showed an increase in leg muscle explosions on high school volleyball teams, although the effect on blocking skills may differ depending on the method used (Manullang et al., 2023; Imandaqurani & Pratama, 2024).

Based on empirical observations on extracurricular volleyball students of Sekolah Menengah Atas Negeri 1 Madang Suku III, students' vertical jumping ability is still not optimal, which has an impact on the effectiveness of the application of attacking and defending techniques during matches. This condition shows the limited explosive power of the leg muscles as one of the important physical components in the game of volleyball. However, research that specifically compares the effectiveness of jump-to-box and barrier jump training methods in increasing the jump height of extracurricular students is still limited. Therefore, this experimental research is important to evaluate and compare the influence of the two training methods on the increase in jump height, as the basis for the preparation of a more effective and science-based training program for the development of school-age volleyball athletes.

Materials and methods

Study participants

The subjects of this study are 24 students who actively participate in volleyball extracurricular activities at State High School 1 Madang Tribe III. The sample determination technique used total sampling, considering that the population was relatively small so that all members of the population met the inclusion criteria and were involved in the study. Inclusion criteria include: (1) being registered as an active participant in volleyball extracurriculars, (2)

not having suffered an injury during the research period, and (3) being willing to participate in the entire series of training programs.

This study uses a quasi-experimental design with a pretest–posttest two group design pattern. Before the treatment was given, all subjects underwent a pretest to measure the initial ability of jump height. The pretest results were then used as the basis for grouping with matching techniques based on equal scores, so that both groups had relatively homogeneous initial ability characteristics. After the matching process, subjects were allocated into two treatment groups of equal amounts.

To strengthen the internal validity, several measures of controlling the disruptor variables were performed, namely: (1) both groups underwent the same frequency, duration, and time of exercise; (2) the training program is carried out outside the school's routine training schedule to avoid overlapping treatments; (3) attendance rates are recorded and only subjects with attendance of at least 80% are included in the analysis; and (4) subjects were instructed not to participate in additional extracurricular exercise programs during the treatment period.

However, external factors such as physical activity outside of school, nutritional intake, and biological maturation processes cannot be strictly controlled and are a limitation of the research. Therefore, the interpretation of the causal relationship between treatment and the increase in jump height is carried out carefully taking into account the potential confounding variables

Study organization

This study applied a pretest-posttest design from two groups included in a quasi-experimental approach, with the aim of analyzing the influence of jump to box and barrier hop training methods. Data collection was carried out using tests and measurements to obtain quantitative data related to jumping ability before and after being given sports treatment. Measurement of jump height is carried out using a vertical jump test (Sepdanius et al., 2019).

Statistical analysis

Prior to the application of inferential statistical analysis, the data are first tested through prerequisite tests, including normality tests and homogeneity tests, to ensure that the assumptions of the analysis are met. The entire data analysis process is carried out with the help of SPSS 26 software to ensure the accuracy and reliability of the research results. This systematic methodological approach allows replication by subsequent researchers and provides a comprehensive overview of the effectiveness of jump-to-box and barrier training methods in improving jumping ability and barrier jump training methods in improving jumping ability.

Results

Before the treatment in the form of *Jump To Box* training, a pretest was first carried out to measure the athlete's jump height as preliminary data. After the implementation of the training program during a predetermined period, a posttest is carried out to find out the changes that have occurred. The results showed an increase in the average height of athletes after participating in the *Jump To Box* training program. as shown in Table 1.

Table 1. Improved *jump to box training results*

Average pretest score	Post-test average	Percentage %
43,8	54,7	24,88%

The results in Table 1 show an average increase of 24.88% after participants participated in the jump to box exercise. The increase indicates that the jump to box training method has a

positive influence on improving participants' abilities. Thus, the application of jump to box exercises has been proven to be effective in improving the performance of research participants.

The jump height test was performed using *vertical jumps* before and after *barrier hops* training. The results show an increase in jump height, as shown in Table 2.

Table 2. Improved *barrier hops training results*

Average pretest score	Post-test average	Percentage %
45,8	57,3	25,09%

Based on Table 2, it can be seen that the average score of participants increased after participating in *barrier hop training*. The average pretest score of 45.8 increased to 57.3 in the post-test. The increase of 11.5 points is equivalent to an increase of 25.09% from the initial value.

This increase shows that *barrier hops* training has a positive impact on improving participants' abilities. Practically, the percentage increase indicates that the training method applied is effective in improving physical performance which is the focus of the measurement in this study.

To provide an overview of the characteristics of the research data, a descriptive analysis was carried out on the pretest and posttest values of the two variables, namely *jump to box* and *barrier hops*. A summary of the results is shown in Table 3.

Table 3. Description of statistical data

	N	Range	Minimum	Maximum	Mean	Std.Deviation
Jump To Box	Pretest 12	63	7	70	43.83	17.85
	Posttest 12	63	18	81	54.75	17.74
Barrier Hops	Pretest 12	39	27	66	45.83	14.68
	Posttest 12	40	38	78	57.33	15.02

The results in table 3 show that the average jump to box score increased from 43.83 in the pretest to 54.75 in the posttest. Meanwhile, in the barrier hops exercise, the average score increased from 4.83 to 57.33. The increase in average scores in both groups showed an improvement in performance after being given the exercise treatment.

The standard deviation values in each group, both before and after, were relatively stable. This shows that the variation in ability between participants did not undergo significant changes and the data obtained tended to be homogeneous. Thus, both exercise methods have a positive impact on the improvement of outcomes measured in this study.

To ascertain whether the pre-test and post-test data are distributed normally, a normality test is performed. Using the Shapiro-Wilk and Kolmogorov Smirnov tests, the following results were obtained in Table 4.

Table 4. Normality Test

		Kolmogrov-smirnov			Shapiro-wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Jump To Box	**Pretest**	.121	12	.200	.961	12	.800
	Posttest	.120	12	. 200	.965	12	.852
Barrier Hops	**Pretest**	.154	12	. 200	.907	12	.193
	Posttest	.139	12	.200	.908	12	.202

Based on the results in table 4, it is known that *the jump to box* data in the post-test shows a significance value greater than 0.05, while *the barrier hops* data in the pre-test and post-test shows a significance value of less than 0.05. These findings indicate that not all data are normally distributed. However, given the relatively small sample size and the *paired sample t-test* which is quite robust against violations of normality assumptions, statistical analysis can still be continued.

The purpose of the homogeneity test is to check the suitability of the variation between the pre-test and post-test results for each variable. The following table shows the test results in Table 5.

Table 5. Homogeneity Test

	Statistik Levene	df1	DF2	Sig.
Based on Mean	.045	3	44	.987

Based on the results of the Levene test, a significance value of 0.987 (based on *the mean*) was obtained. The value is greater than 0.05, so it can be concluded that the variance of vertical *jump results* data in both groups is homogeneous, which means that the measurement results between the pretest and posttest come from a uniform group.

Hypothesis testing was carried out by comparing the pretest and posttest results for the jump to box variable using a pair sample t-test. The test results are shown in Table 6:

Table 6. Research Hypothesis for the Jump To Box Training Group

Pair	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
Pretest - Posttest_Jump_To_Box	10.917	0.669	0.193	Lower 11.341	Upper 10.492	56.564	11	0.001

The results of the pre-test and post-test vertical jump showed a significant difference, which was indicated by the sig. (2-tailed) value of 0.001 (< 0.05). thus, it can be concluded that the jump to box exercise significantly increases the jump height of volleyball extracurricular students of State High School 1 Madang Suku III.

To find out whether barrier hops training also provides an increase in the jump height

of extracurricular students, a hypothesis test was then carried out on the barrier hops variable. The results of these tests are presented in Table 7.

Table 7. Research Hypothesis for the Barrier Hops Training Group

Pair	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
Pretest - Posttest_ barrier hops	11.500	0.674	0.195	Lower 11.928	Upper 11.072	59.088	11	0.001

The results of the pre-test and post-test vertical jump showed a significant difference, which was indicated by the Sig. (2-tailed) value of 0.001 (< 0.05). Thus, it can be concluded that barrier hops practice significantly increases the jump height of volleyball extracurricular students of State High School 1 Madang Suku III.

Discussion

The results showed that the application of the Jump to Box and Barrier Hops training methods had a significant influence on increasing the explosiveness of the lower leg muscles. This is shown by an average increase of 24.88% in the Jump to Box exercise group and 25.09% in the Barrier Hops training group. The findings indicate that both plyometric training methods are effective in optimizing the explosive abilities of the lower leg muscles. This adaptation is supported by findings (Shuai et al., 2025) Specifically, the Jump to Box exercise provides benefits in increasing jump height through the development of explosive strength, movement coordination, and maximum extension ability in the ankle, knee, and pelvic joints. This exercise also helps athletes improve control during the push-up and landing phases, so that the efficiency of vertical movement is more optimal. Meanwhile, (Fischetti et al., 2019) explained that Barrier Hops training contributes to an increase in jump height through increased muscle reactivity (stretch-shortening cycle), contraction speed, and the ability to maintain rhythm and jump continuity. The repetitive movement characteristics of Barrier Hops train the elastic response of muscles and tendons, which play an important role in producing stronger and faster repulsion, thus having a direct impact on improving vertical jump performance.

Jump to box training is a form of plyometric exercise that emphasizes the ability to produce vertical force explosively by utilizing body weight. The results of this study show that jump to box training has a significant effect on improving the jump height of volleyball extracurricular students. These findings indicate that training which optimizes the stretch shortening cycle mechanism can enhance lower-limb explosive power, which plays an important role in supporting volleyball-specific movements such as spiking and blocking.

Physiologically and biomechanically, jump-to-box training involves the synergistic activation of the main lower-limb muscles working explosively, thereby increasing the rate of force development. This neuromuscular adaptation is consistent with previous studies showing that vertical jump–based plyometric training is effective in improving vertical jump ability in athletes and students (Vida et al., 2025a; Aldo et al., 2024; Yu et al., 2025). In the context of school physical education and sports, these findings confirm that jump-to-box training can be systematically and safely integrated as part of students' physical training programs.

Barrier hops training has also been proven to have a significant effect on improving students' jump height. The repetitive and reactive nature of this exercise requires rapid neuromuscular coordination and efficient energy transfer during the push-off phase. The results of this study are consistent with previous research (Zheng et al., 2025; Jatra et al., 2025), and

strengthened by international studies that state that reactive plyometric exercises are effective in increasing leg muscle explosiveness and vertical jump performance (Kons et al., 2023).

These findings indicate that both exercise methods have relatively equal effectiveness in increasing jump height. These results are consistent with research (Deng et al., 2024) as well as systematic reviews indicating that variations of plyometric training produce comparable performance adaptations, as long as training principles such as intensity and volume are applied appropriately (Markovic et al., 2010; Ramirez-campillo et al., 2022).

Thus, in the context of school sports development, jump-to-box and barrier hops training can be used as alternative plyometric training methods that are practical and flexible. Teachers and coaches have the freedom to select or combine these two methods according to students' characteristics, learning objectives, and available facilities, without reducing their effectiveness in improving vertical jump ability.

Conclusions

According to the study's findings, the high jump ability of volleyball extracurricular students can be significantly improved through Jump To Box and Barrier Hop training. Both forms of exercise are part of plyometric exercises that emphasize the stretch-shortening cycle (SSC), which is a combination of eccentric and concentric contractions that take place quickly and explosively. Through this mechanism, Jump To Box and Barrier Hop exercises are able to increase leg muscle explosiveness, neuromuscular coordination, and vertical movement efficiency.

This improvement directly contributes to the technical performance in the game of volleyball, especially in the ability to smash, block, and jump serve. Exercises that are carried out systematically and progressively can increase the recruitment of fast-twitch muscle fibers, speed up reaction time, and improve explosive movement patterns during pushback. Thus, students are able to achieve more optimal and stable jump heights during the game.

Overall, the regular application of Jump To Box and Barrier Hop exercises can be used as an effective strategy in the physical training program of volleyball extracurricular students, both to improve vertical jump performance and to support general physical readiness. The results of this study reinforce the view that the explosiveness of the leg muscles is a very important component of physical condition in the sport of volleyball. Therefore, both forms of training deserve to be an integral part of the physical training program for school athletes.

The recommendation for future researchers is to expand the study by comparing the effectiveness of Jump To Box and Barrier Hop separately or a combination of the two to determine the most optimal method for increasing jump height. In addition, future research may test variations in intensity, volume, frequency, and duration of exercise to obtain more effective and efficient exercise protocols. It is also important to replicate the research in different populations (e.g., junior high school, high school, or female athletes) and to use biomechanical analysis or technology-based measurements (such as sensor-based vertical jump tests) to obtain objective validation of the increased explosiveness of the leg muscles resulting from the exercise program.

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Conflict of interest

The author states that there is no conflict of interest in the implementation or publication of this research. The entire research process is carried out independently and objectively in accordance with scientific principles.

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Information about the authors:

Muhammad Zen Almunawar: muhammadzenalmunawar@gmail.com, Department of Master Study Program In Physical Education,Universitas PGRI Palembang, Indonesia

Siti Ayu Risma Putri: sitiayurisma@gmail.com, https://orcid.org/0009-0008-3372-7093, Department of Master Study Program In Physical Education,Universitas PGRI Palembang, Indonesia

Jujur Gunawan Manullang: jujurgm@univpgri-palembang.ac.id, https://orcid.org/0000-0001-7796-1158, Department of Master Study Program In Physical Education,Universitas PGRI Palembang, Indonesia

Grace Kharisma Tambunan: gracetbn19@gmail.com, https://orcid.org/0009-0002-6029-9887, Department of Master Study Program In Physical Education,Universitas PGRI Palembang, Indonesia

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