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The Effect of Jump Rope Training on Vertical Jump Height in Female Volleyball Extracurricular Students

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ABSTRACT

This study aimed to examine the effect of jump rope training on vertical jump height among female students participating in volleyball extracurricular activities at SMP Negeri 28 Surabaya. Vertical jump height represents a key indicator of lower-limb explosive power and plays a crucial role in the effective execution of smash and block techniques in volleyball. Conceptually, jump rope exercise is categorized as a low- to moderate-intensity plyometric training method that stimulates the stretch-shortening cycle (SSC), enhances neuromuscular coordination, and improves rate of force development. The research employed a pre-experimental One Group Pretest–Posttest design involving 20 female students selected through saturated sampling. The intervention consisted of a structured jump rope training program conducted for four weeks with a frequency of three sessions per week. Vertical jump height was measured using the Jump MD vertical jump test device. Data analysis included descriptive statistics, the Shapiro–Wilk normality test, and a paired sample t-test at a significance level of 0.05. The results demonstrated an increase in mean vertical jump height from 33.75 cm (pretest) to 40.95 cm (posttest). The paired sample t-test revealed a significance value of 0.01 ($p < 0.05$), indicating a statistically significant improvement following the intervention. These findings empirically confirm that jump rope training effectively enhances lower-limb explosive power and vertical jump performance in junior high school female volleyball students.

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INTRODUCTION

Volleyball is a sport that demands coordination, reaction time, muscle strength, and integrated teamwork. Technically, each team is given three touches to return the ball to the opponent's court, so the effectiveness of attack and defense depends heavily on the quality of basic techniques such as passing, serving, smashing, and blocking. Among these techniques, smashing and blocking directly contribute to points scored, making vertical jump ability a determining component of game performance (Sheppard et al., 2018; Marques et al., 2020).

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Biomechanically, smashing requires optimally coordinated approach, take-off, arm swing, ball contact, and landing phases. Jump height determines the point of contact and a sharper angle of attack, thus increasing the chance of scoring (Palao & Valadés, 2019). In the context of physical education and extracurricular activities in junior high schools, mastery of these techniques is often suboptimal due to limited physical condition of students, particularly in leg muscle power (Ramirez-Campillo et al., 2021).

Observations of extracurricular girls' volleyball activities at SMP Negeri 28 Surabaya indicate that most students experience limitations in achieving maximum jump height. This impact is evident in the low effectiveness of smashes and blocks, which tend to be easily read and anticipated by opponents. This condition indicates that the implemented training program has not been specifically directed at increasing leg power through a structured approach based on scientific training principles such as overload, specificity, and progression (Bompa & Buzzichelli, 2019; Suchomel et al., 2018).

If this condition is not addressed systematically, the achievement development process at the school level will stagnate. Therefore, training interventions are needed that are practical, safe, and easy to implement in the school environment, yet still effective in improving students' vertical jump ability.

Vertical jump ability is widely recognized as an indicator of leg muscle power and neuromuscular capacity in competitive sports (Cormie et al., 2018). Physiologically, vertical jump performance is influenced by maximal strength, rate of force development (RFD), and the efficiency of the stretch–shortening cycle (SSC) mechanism in the gastrocnemius, soleus, quadriceps, and gluteus maximus muscles (Markovic & Mikulic, 2019; Philipp et al., 2023). Various training approaches have been developed to improve leg power, including resistance training, plyometric training, and complex training (Ramirez-Campillo et al., 2020; Moran et al., 2018). In the context of adolescents, light to moderate intensity plyometric training has been shown to be effective and relatively safe when performed with proper supervision (Lloyd et al., 2016; Behm et al., 2017).

One form of exercise that falls into the light plyometric category is jump roping or rope skipping. This exercise involves repeated, high-frequency explosive contractions, which stimulate neuromuscular adaptation and improve tendon elasticity and intramuscular coordination (Chaouachi et al., 2020). Empirical studies have shown that rope jump training can improve vertical jump height, agility, and coordination in young athletes (Makhlouf et al., 2018; Yanci et al., 2021).

Furthermore, rope jump training offers advantages in terms of equipment efficiency, low cost, and flexibility in training intensity. Research in adolescent volleyball athletes shows that a 6–8-week rope skipping program can significantly increase leg power compared to a control group (Prieske et al., 2019; Negra et al., 2020). In a school setting, this form of training is considered appropriate for student characteristics because it can be modified through intervals, tempo variations, and combinations of movement patterns (Faigenbaum et al., 2020).

Pedagogically, the implementation of structured physical training in extracurricular activities also contributes to improving students' physical fitness and motivation to practice

(Balyi et al., 2019). Thus, jump rope training has a strong theoretical and empirical basis as an alternative intervention to improve students' vertical jump ability.

Although various studies have demonstrated the effectiveness of plyometric training on improving vertical jump in athletes, most studies have focused on competitive athletes or late adolescents (Marques et al., 2020; Ramirez-Campillo et al., 2021). Research specifically examining the effectiveness of jump rope training in junior high school girls in an extracurricular context is still limited.

Furthermore, several studies have compared rope skipping with other methods such as box jumps or depth jumps, but few have tested its effectiveness as a stand-alone, structured program in non-elite populations (Negra et al., 2020). The variation in previous research results also shows inconsistencies, particularly regarding intervention duration and training intensity (Prieske et al., 2019).

Another gap lies in the lack of integration of neuromuscular adaptation approaches into the design of school training programs. Many extracurricular programs remain repetitive without clear periodization, preventing optimal physiological adaptation. Thus, experimental research is needed to systematically test the effect of jump rope training on increasing vertical jump height in female junior high school students using a controlled and measurable pretest-posttest design. This study aims to analyze the effect of jump rope training on increasing vertical jump height in female volleyball extracurricular participants at SMP Negeri 28 Surabaya. Specifically, this study examines changes in vertical jump height before and after a training intervention designed based on the principles of progression and overload over a specific duration.

The novelty of this study lies in: (1) The population focus is on female junior high school students in the context of school extracurricular activities, which has been underexplored in power training research; (2) The intervention design utilizes jump rope as the primary method for increasing leg power, not simply as supplementary training; and (3) The integration of a neuromuscular adaptation approach based on SSC in a non-elite physical education setting.

Conceptually, this study strengthens the model of the relationship between light plyometric training and neuromuscular adaptation in early adolescence. Empirically, the research results are expected to provide a scientific basis for physical education teachers and school coaches in designing effective, efficient, and applicable training programs to improve smash and block performance through vertical jump ability. Thus, this study not only contributes to the development of school-based sports science literature but also strengthens the practice of developing early-age volleyball performance through a structured training approach based on current scientific evidence.

METHODS

This study employed a quantitative approach with a pre-experimental One Group Pretest–Posttest design to examine the effect of jump rope training on vertical jump height in female volleyball extracurricular students at SMP Negeri 28 Surabaya.

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Quantitative experimental methods are widely recommended in sports science research to evaluate causal relationships between training interventions and performance outcomes through objective measurement and statistical testing (Behm et al., 2017; Hopkins et al., 2019). The pretest–posttest format allows the identification of performance changes following a structured intervention and is commonly used in school-based training studies (Ramirez-Campillo et al., 2020; Moran et al., 2018).

The research was conducted in January 2025 at SMP Negeri 28 Surabaya, East Java. The population consists of all female students participating in the school's volleyball extracurricular program. Because the total population was fewer than 30 individuals, a saturated sampling technique was applied, involving all 20 eligible students as research participants. This approach aligns with methodological recommendations for small-group experimental designs in youth sport contexts (Lloyd et al., 2016; Faigenbaum et al., 2020). All participants were healthy, actively attending extracurricular training, and had no lower-limb injuries during the study period.

The independent variable was a structured jump rope training program implemented for four weeks with a frequency of three sessions per week (12 sessions total). Rope skipping is classified as a low-to-moderate intensity plyometric activity that stimulates the stretch–shortening cycle (SSC), enhances neuromuscular coordination, and improves rate of force development (RFD) in the lower extremities (Markovic & Mikulic, 2019; Chaouachi et al., 2020; Philipp et al., 2023). Empirical studies have demonstrated that short-term plyometric and rope-based interventions (4–8 weeks) significantly improve vertical jump performance in adolescents (Makhlouf et al., 2018; Negra et al., 2020; Yanci et al., 2021).

The training program was arranged progressively based on overload and progression principles (Bompa & Buzzichelli, 2019). During weeks 1–2, participants performed jump rope for 1 minute per set across 3 sets, with 3-minute passive recovery between sets. During weeks 3–4, duration was increased to 2 minutes per set with the same number of sets and rest interval. This progressive volume adjustment is consistent with youth plyometric guidelines emphasizing gradual load increases to optimize adaptation while minimizing injury risk (Behm et al., 2017; Lloyd et al., 2016). All sessions were supervised to ensure proper technique, landing mechanics, and safety.

The dependent variable was vertical jump height (cm), assessed using a vertical jump test with a Jump MD device, which calculates jump height based on flight time. Vertical jump testing is widely validated as a reliable indicator of lower-limb power and neuromuscular performance in volleyball players (Cormie et al., 2018; Sheppard et al., 2018; Marques et al., 2020). Each participant performed three maximal countermovement jumps, and the highest score was recorded, following standardized testing protocols (Moran et al., 2018; Prieske et al., 2019).

Data collection was conducted before (pretest) and after (posttest) the 4-week intervention. Descriptive statistics (mean, minimum, maximum, standard deviation) were calculated to summarize performance characteristics. Assumption testing included a normality test to determine data distribution. Hypothesis testing was

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performed using a paired sample t-test at a significance level of $\alpha = 0.05$ to evaluate whether there was a statistically significant improvement in vertical jump height following the jump rope training intervention. The use of parametric paired analysis is consistent with experimental sport training research examining within-group performance changes (Hopkins et al., 2019; Ramirez-Campillo et al., 2021).

RESULTS AND DISCUSSION

Result

This study was conducted on female students participating in volleyball extracurricular activities at SMP Negeri 28 Surabaya. All research subjects received treatment in the form of a structured jump rope training program implemented for one month in accordance with the predetermined research design. The training was administered with the aim of improving lower limb muscle power, which directly contributes to vertical jumping ability in volleyball. Data collection was carried out in two measurement stages, namely the initial test (*pretest*) and the final test (*posttest*). The pretest was conducted prior to the training intervention to determine the students' initial vertical jump ability, while the posttest was administered after the completion of the entire jump rope training program.

The comparison between pretest and posttest results was used to determine changes in vertical jump ability after participation in the training program. All measurement data were then processed and analyzed using statistical software to obtain objective and accurate results in accordance with the research objectives. Descriptive statistical analysis was employed to provide a general overview of the research data. The analyzed data included the mean, minimum, maximum, and standard deviation of vertical jump height measured during the pretest and posttest. The analysis results indicated differences in vertical jump height values before and after the jump rope training intervention. The mean vertical jump height in the posttest was higher than that in the pretest. In addition, the minimum and maximum values in the posttest also increased compared with the pretest. The obtained standard deviation showed that the variation in students' vertical jump data remained within a relatively uniform range, indicating that the improvement in jumping ability occurred in the majority of research subjects. A summary of the descriptive statistical analysis results is presented in Table 1 below.

Table 1.
Descriptive Statistical Test Results

	N	Minimum	Maximum	Mean	Std. Deviation
PRETEST	20	27,00	43,00	33,7500	364,005
POSTTEST	20	30,00	55,00	40,9500	585,325
Valid N (listwise)	20				

Based on Table 1, the mean vertical jump height of the female students increased by 7.2 cm after the jump rope training intervention. Prior to hypothesis testing, the research data were first examined to ensure that the assumptions for statistical analysis

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were satisfied. The prerequisite test employed was the Shapiro–Wilk normality test, as the sample size was fewer than 50 participants. The results of the normality test showed a significance value of 0.481 for the pretest and 0.743 for the posttest. Both values were greater than 0.05, indicating that the vertical jump height data were normally distributed. Since the normality assumption was met, hypothesis testing could be conducted using parametric statistical analysis. A summary of the normality test results is presented in Table 2.

Table 2.
Normality Test Results

Data	Kolmogorov–Smirnov Statistic	df	Sig.	Shapiro–Wilk Statistic	df	Sig.
Pretest	0,168	20	0,14	0,957	20	0,481
Posttest	0,101	20	0,2*	0,969	20	0,743

Hypothesis testing was conducted to determine whether jump rope training had an effect on the vertical jump height of female students participating in volleyball extracurricular activities at SMP Negeri 28 Surabaya. Since the data were obtained from two measurements within the same group, the statistical test used was the paired sample *t*-test. A summary of the hypothesis testing results is presented in Table 3.

Table 3.
Hypothesis Test Results (Paired Sample t-Test)

Pair	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pretest – Posttest	-7,2	4,36011	0,97495	-9,24059	-5,15941	-7,385	19	<0,001

The analysis results indicated a significance value of 0.01. This value was lower than the significance level of 0.05; therefore, the null hypothesis was rejected and the alternative hypothesis was accepted. These findings demonstrate that jump rope training had a significant effect on improving the vertical jump height of the female students.

The results of the study indicated that female students participating in volleyball extracurricular activities at SMP Negeri 28 Surabaya experienced a significant improvement in jumping ability as a result of the jump rope training program. Statistical analysis of the difference in mean vertical jump height between the pretest and posttest confirmed this improvement. The data analysis demonstrated that jump rope training had a significant effect on the jumping performance of junior high school students at SMP Negeri 28 Surabaya. The findings showed that the mean vertical jump height increased from 33.75 cm to 40.95 cm. The hypothesis testing results further supported this finding, with a significance value of 0.01 < 0.05. Therefore, the hypothesis stating that jump rope training has an effect can be accepted.

This improvement indicates a change in jumping ability that occurred after the students participated in a regularly implemented training program during the research period, as reflected in the clear difference between the initial and final measurement results obtained from the data.

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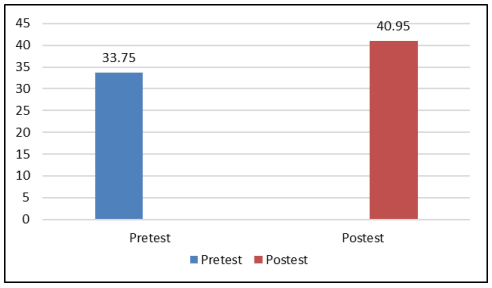

Picture 1.
Presentase Rata-rata Pretest dan Postttest

Discussion

The findings of this study indicate that jump rope training significantly improved vertical jump height in female volleyball extracurricular students at SMP Negeri 28 Surabaya. This result reinforces the theoretical framework that rope skipping, as a form of low- to moderate-intensity plyometric training, effectively enhances lower-limb explosive power through neuromuscular adaptation. Explosive power refers to the capacity of muscles to generate maximal force in minimal time, which is strongly associated with rate of force development (RFD) and stretch–shortening cycle (SSC) efficiency (Cormie et al., 2018; Suchomel et al., 2018). In volleyball performance, this capacity is fundamental for executing high-quality smash and block actions.

Physiologically, the improvement in vertical jump height observed in this study can be explained through the activation of the SSC mechanism. Rope jumping requires rapid eccentric–concentric muscle actions in the gastrocnemius, soleus, quadriceps, hamstrings, and gluteus maximus muscles. During ground contact, elastic energy is stored in the musculotendinous unit and subsequently released during the concentric phase, resulting in greater propulsion force (Markovic & Mikulic, 2019; Philipp et al., 2023). Regular exposure to this loading pattern increases tendon stiffness, intermuscular coordination, and neural drive, thereby reducing ground contact time while increasing take-off velocity (Ramirez-Campillo et al., 2020; Chaouachi et al., 2020).

The present findings align with previous empirical studies demonstrating that short-term plyometric interventions significantly improve vertical jump performance in adolescents. Negra et al. (2020) reported meaningful improvements in countermovement jump height following 6 weeks of plyometric training in youth athletes. Similarly, Makhlouf et al. (2018) and Yanci et al. (2021) found that rope-based jump programs improved explosive strength and neuromuscular coordination in early-age athletes. Although the current study implemented a four-week intervention, the statistically significant increase in vertical jump height suggests that even relatively short, structured rope jump programs can stimulate measurable adaptations when designed progressively.

From a biomechanical perspective, volleyball-specific movements such as the smash approach and block jump require optimal synchronization between lower-limb force production and upper-limb swing mechanics (Sheppard et al., 2018; Palao & Valadés, 2019). Increased vertical jump height increases the athlete's ability to contact the ball at a higher point, improving attack angle and reducing the likelihood of being

blocked. The improvement observed among SMP Negeri 28 Surabaya students therefore has direct implications for technical execution during gameplay. Marques et al. (2020) emphasize that lower-limb power is one of the strongest predictors of competitive volleyball performance, particularly in offensive efficiency.

Another important explanation relates to neuromuscular coordination. Rope jump training involves rhythmic, repetitive movements that enhance motor unit recruitment and firing frequency. According to Behm et al. (2017), neural adaptations often precede hypertrophic changes during short-term training, particularly in adolescents. This suggests that the improvements observed in this study were likely driven more by neural efficiency than by structural muscle enlargement. Such neural adaptations include improved synchronization of motor units, increased excitability of the motor cortex, and enhanced proprioceptive control (Lloyd et al., 2016; Faigenbaum et al., 2020).

The age characteristics of the sample also contributed to the effectiveness of the intervention. Adolescence is recognized as a critical period for developing biomotor abilities due to rapid neuromuscular maturation (Moran et al., 2018). During this phase, the nervous system demonstrates high plasticity, allowing faster adaptation to plyometric stimuli. Research by Ramirez-Campillo et al. (2021) highlights that youth athletes experience significant improvements in jump performance when exposed to structured plyometric training under proper supervision. Thus, the female junior high school participants in this study were in an optimal developmental stage for explosive power enhancement.

In addition, rope skipping offers advantages in school settings. Compared to high-intensity plyometric drills such as depth jumps or box jumps, rope jumping provides lower mechanical stress while still stimulating SSC adaptation (Chaouachi et al., 2020). This makes it suitable for non-elite or school-based athletes, reducing injury risk while promoting consistent training participation. Prieske et al. (2019) also note that rope-based training improves reactive strength and coordination without requiring complex equipment, making it highly applicable in limited-resource environments such as school extracurricular programs.

The principle of progressive overload applied in this study further supports the observed outcomes. Increasing training duration from one to two minutes per set across the intervention period aligns with periodization principles recommended in youth strength and conditioning literature (Bompa & Buzzichelli, 2019). Progressive loading ensures continuous neuromuscular stimulus, preventing adaptation plateaus. According to Suchomel et al. (2018), consistent incremental stress is essential for improving power output and RFD. The structured design of the training program likely contributed to the measurable improvements in vertical jump height.

While the results are promising, it is important to acknowledge that vertical jump performance is multifactorial. Factors such as muscle strength, technique, coordination, and psychological readiness also influence performance (Cormie et al., 2018; Marques et al., 2020). Nevertheless, the significant pretest–posttest difference indicates that jump rope training played a meaningful role in enhancing lower-limb power among participants.

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From a practical standpoint, these findings provide evidence-based support for integrating rope jump exercises into volleyball extracurricular training programs. The improvements in jump height not only contribute to technical performance but may also enhance students' confidence and motivation during gameplay. Given that volleyball performance at the school level often depends on physical readiness rather than tactical complexity, targeted interventions such as rope jump training can yield substantial benefits.

In conclusion, the discussion confirms that jump rope training effectively increases vertical jump height through SSC optimization, neuromuscular adaptation, and improved motor coordination in adolescent female volleyball students. The findings are consistent with contemporary sport science literature and reinforce the relevance of plyometric-based interventions in youth athletic development. By implementing structured and progressive rope jump programs, schools can improve lower-limb explosive power safely and efficiently, thereby supporting both technical performance and long-term athlete development in volleyball.

CONCLUSION

Based on the findings of this study, it can be concluded that jump rope training produced a significant and meaningful improvement in vertical jump height among female volleyball extracurricular students at SMP Negeri 28 Surabaya. The pretest results indicated that the students' initial vertical jump performance was relatively low (mean = 33.75 cm), reflecting limited lower-limb explosive power. After a four-week structured and progressive jump rope training program, the posttest mean increased to 40.95 cm, demonstrating a substantial improvement in jumping ability. Statistical analysis using the paired sample t-test confirmed that this improvement was significant, leading to the acceptance of the alternative hypothesis.

Conceptually, these results support contemporary sport science literature emphasizing that low- to moderate-intensity plyometric exercises, such as rope skipping, effectively stimulate the stretch-shortening cycle (SSC), enhance neuromuscular coordination, and increase the rate of force development in adolescents. Empirically, the findings reinforce evidence that short-term, well-structured plyometric interventions can improve explosive power in youth populations when applied with appropriate progression and supervision.

Practically, jump rope training can be integrated as a simple, cost-effective, and safe method within school volleyball programs to enhance lower-limb power and support technical performance, particularly in smash and block execution.

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