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Hanging Ball and Resistance Band Training in Extracurricular Volleyball Games of High School Students

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ABSTRACT

Extracurricular students at High School 25 Bone struggle to acquire the overhead serve, a fundamental volleyball first attack technique. Innovative training approaches are needed to improve pupils' service accuracy and strength. This study examines the effects of hanging ball and resistance band training on overhead serve skills and the effectiveness of each on extracurricular students at High School Bone. This research is a pretest-posttest group quasi-experiment. All 30 High School 25 Bone extracurricular volleyball players are studying. Total sampling was utilized to divide the sample into two groups: hanging ball training and resistance band training. A pre- and post-treatment overhead serve skill test was used. T-tests at 0.05 were used to assess data. The results of the study showed that (1) there was a significant effect of hanging ball training on overhead service skills with a calculated t-value (12.435) > t-table (2.144); (2) there was a significant effect of resistance band training on overhead service skills with a calculated t-value (11.297) > t-table (2.144); and (3) there was a significant difference in effect between the two training methods, where the calculated t-value (3.092) > t-table (2.048). Based on the comparative results, one of the methods showed more prominent effectiveness in improving service results. This study helps High School 25 Bone coaches and sports teachers choose the proper training approaches to develop basic volleyball techniques. These data should improve sports science references for youth athlete training students.

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1. INTRODUCTION

Sports are a crucial pillar of the national education system, aiming not only to maintain physical fitness but also to build character, discipline, and achievement (Habyarimana et al., 2022). In the Physical Education, Sports, and Health (PJOK) curriculum, volleyball occupies a strategic position as one of the most popular team sports (Hidayat et al., 2025). Volleyball is not simply a game of passing over the net but rather a manifestation of central nervous system coordination, muscle strength, and

tactical intelligence (Akhir et al., 2025; Juhanis & Nurulita, 2024; Purnomo et al., 2022; Saputra et al., 2022).

At the high school level, the development of volleyball potential is not limited to formal classroom hours but is accelerated through extracurricular programs (Husain, 2025; Teshome et al., 2022). The High School 25 Bone, as one of the educational institutions in Bone Regency, has positioned volleyball as a flagship extracurricular activity. Historically, this school has consistently participated in various inter-student competitions. However, the reality on the ground shows a significant gap between active participation and achievement. Despite annual preparation, achieving maximum success in reaching the championship podium remains an unresolved challenge. An intriguing phenomenon observed at the High School 25 Bone is the high level of student determination and enthusiasm. Initial observations indicate that the volleyball court is always bustling with activity, both during physical education (PJOK) lessons and during afternoon extracurricular training sessions. Infrastructure support is also considered very adequate; the availability of a standard court and enough balls should be a catalyst for the development of talented student athletes.

However, this high level of interest and the availability of facilities are inversely proportional to the quality of performance during competitions. This raises a paradox: why, despite the presence of enthusiastic human resources and comprehensive facilities, have we yet to achieve success? Through in-depth discussions with extracurricular instructors and PJOK teachers, it was identified that the root of the problem lies in a weak mastery of fundamental basic techniques, particularly the overhead serves.

In the dynamics of modern volleyball, the serve is no longer viewed simply as the "opening shot" or the act of initiating a rally. The serve has transformed into a crucial first attack (Altundag et al., 2024; Caldeira et al., 2024; Cavedon et al., 2024). A player who master’s the overhead serve with high accuracy and lethal speed can immediately score a point (ace) or at least disrupt the opponent's attack flow (set-up).

The reality on the ground shows that extracurricular students at High School 25 Bone still have low self-efficacy. Their serves tend to have slow, parabolic trajectories, are easy to anticipate (receive), or even often fail to clear the net due to a lack of power. This lack of accuracy and power indicates problems in two aspects: movement mechanics (technique) and arm muscle strength (physics). Without mastery of the upper serve, a team will always be on the defensive and lose momentum to dominate the match.

To overcome these technical obstacles, a systematic and measurable training intervention is required. Training is essentially a systematic process of repeated practice with increasing training load (Impellizzeri et al., 2023; Macedo et al., 2024). The main goal is to improve organ function so that athletes can perform movements more efficiently and effectively. Silva et al. (2023) emphasized that training is an individual player's preparation to achieve the highest level of performance, both individually and collectively. In the context of the overhead serve, the most dominant physical components are arm and shoulder power, as well as hand-eye coordination (Nugraha et al., 2025). Therefore, conventional training models that rely solely on repeating serves

without assistive equipment are considered ineffective in accelerating students' neuromuscular adaptation.

Researchers propose a training model that combines two instruments: a resistance band and a hanging ball. (1) Resistance band: This tool offers dynamic elastic loading. The use of a resistance band with an overhead serve technique approach aims to strengthen the rotator cuff and deltoid muscles specifically along the service pathway (Rahmadani et al., 2025). This differs from general weight training in the gym; resistance bands allow students to train strength precisely as their arms swing. Medium resistance is chosen to ensure students maintain proper form without being distracted by excessive weight. (2) Hanging Ball: The use of a hanging ball aims to improve the mechanics of hand-to-ball impact. The primary concerns for students are inconsistent contact points and coordination while the ball is in the air. With a hanging ball, the variable of "ball bouncing wildly" is temporarily eliminated, allowing students to focus fully on their arm swing technique, highest point of contact, and follow-through.

Sociological evidence suggests that many school-level coaches still rely on traditional, monotonous training methods (Romansa, 2025). A lack of literacy regarding the use of modern equipment such as resistance bands slows recovery and increases power (Daryanti Saragih et al., 2022; de Beukelaar & Mantini, 2023). Training innovations that combine muscle strengthening through resistance bands and technique improvement through a hanging ball are expected to be a practical and economical solution yet have a significant performance impact. This integration addresses not only physical aspects but also psychological ones. Repeatedly executing powerful and accurate serves while practicing with the equipment will boost students' confidence when facing stressful match situations.

Building upon the problem identification and solution analysis above, the researcher considers it necessary to conduct an in-depth scientific study on the effectiveness of this training model. By optimizing the function of resistance bands as explosive power enhancers and hanging balls as technique correctors, it is hoped that students at High School 25 Bone can make a leap in achievement. Changing the training paradigm from simply "playing" to "training scientifically" is the main key. Through this approach, it is hoped that the problem of low quality of upper-level services can be resolved permanently so that High School 25 Bone will not only excel in enthusiasm and facilities but also be dominant in achievements at the regional and national levels.

2. METHOD

This study employed a quantitative approach with a quasi-experimental method. This approach was chosen because the data collected was numerical and analyzed using statistical procedures to test hypotheses. The research design employed a Two-Group Pretest-Posttest Design. In this design, the subjects were divided into two groups to examine the cause-and-effect relationship of the intervention. Researchers conducted a pretest before the treatment and a posttest after the entire training program was completed. This study was conducted on the volleyball court of High School 25 Bone,

Bone Regency, South Sulawesi. The data collection and treatment sessions lasted for two months.

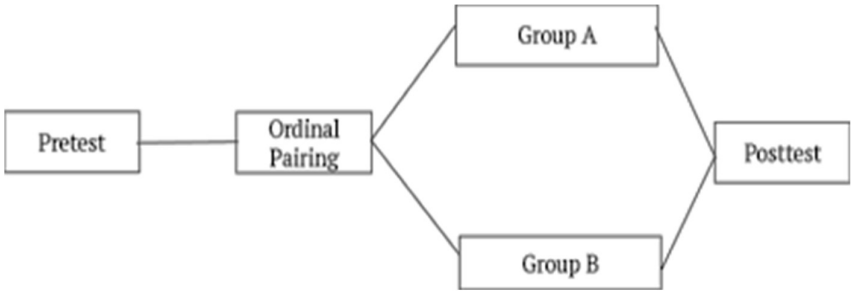

Figure 1. Two-Group Pretest-Posttest Design

All students actively enrolled in extracurricular volleyball activities at High School 25 Bone, totaling 30 students. The sampling technique used was census or total sampling. Given the relatively small and accessible population, the researcher included the entire population (30 students) as a sample to increase the validity and generalizability of the research results.

The primary instrument used to measure students' technical abilities was the Volleyball Skills Test by Richard H. Cox (Ikhwani, 2018), specifically the overhead serves test item. Data collection consisted of two main stages:

- Performance Test: (1) Pre-test: Conducted to determine students' initial overhead serve abilities before receiving a training program. (2) Treatment: Students were given an intervention in the form of a training program using a hanging ball and resistance band for 16 sessions. (3) Post-test: Conducted after 16 training sessions to measure the extent of improvement in overhead serve abilities after the treatment.
- Documentation: Referring to Arikunto's theory (2011), documentation was conducted to collect supporting data in the form of student attendance records, training journals, activity photos, and relevant literature to support the objectivity of the research in the field.

The training program was systematically designed, focusing on increasing arm power through resistance bands and accuracy using the hanging ball. The training was conducted three times a week throughout the study period, with gradually increasing intensity (progressive overload).

The data collected was statistically processed using data analysis software. The data analysis stages included:

- Descriptive Analysis: Used to describe data characteristics such as the mean, median, standard deviation, and minimum and maximum values. Prerequisite Analysis Tests: (1) Normality Test: To ensure that the data obtained were normally distributed (using the Kolmogorov-Smirnov or Shapiro-Wilk test). (2) Homogeneity Test: To determine whether the data variances from both groups were homogeneous or equal.
- Hypothesis Testing (T-Test): Using a Paired Sample T-Test to determine the significance of the difference between the pre-test and post-test results, to

demonstrate the effect of hanging ball and resistance band training on overhead serve ability.

3. RESULTS AND DISCUSSION

Results

Hanging Ball Training on the Upper Serve Skill in Volleyball Games of Extracurricular Volleyball Students

The data analysis for Group A concluded that the hanging ball training intervention significantly improved the upper hand serve skills of extracurricular volleyball students at High School 25 Bone. Empirical evidence indicates that the calculated t-value of 12.435 is significantly higher than the t-table value of 2.144 (12.435 > 2.144). Furthermore, a two-tailed significance value of 0.000 was obtained, which is statistically significantly lower than the 0.05 significance level (alpha).

These test results provide a strong basis for rejecting the null hypothesis (H_0) and accepting the alternative hypothesis (H_1), indicating a significant difference in performance between the pre-test and post-test measurements. Substantially, these findings confirm that the hanging ball training pattern can correct movement mechanics and consistency of hand contact with the ball, thereby effectively improving the quality of students' upper hand serves. Thus, the implementation of hanging ball training is worth recommending as one of the routine training programs to increase attack power through service in the High School 25 Bone volleyball team.

Table 1. Results of Hypothesis Test Analysis (Paired Sample T-Test) Group A

Variable	Measurement	Mean	(Mean Diff)	t-count	t-table	Significance (p−value)	Description
Top Service	Pre-test	15	3.6	12.435	2.144	0	Significant
	Post-test	18.6					(H1 Accepted)

Hanging ball training significantly improved the overhead serve skills of volleyball extracurricular students at High School 25 Bone. The use of a static (hanging) ball proved effective in improving the consistency of ball contact, thereby improving students' overall serve results.

Resistance Band Training on the Overhand Serve Skills in Volleyball Games of Extracurricular Volleyball Students

The results of the data analysis, it can be concluded that the resistance band training intervention in Group B has a significant impact on improving the overhead serve skills of extracurricular volleyball students at High School 25 Bone. Statistical evidence shows a calculated t value of 11.297, which substantially exceeds the t table value of 2.114 (11.297 > 2.114). Supported by a significance value of 0.000, which is far below the alpha threshold = 0.05, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted. This confirms the existence of a real difference between

the pretest and posttest results, while also proving the effectiveness of elastic weight training in improving students' overhead serve technique performance.

Table 2. Results of Statistical Analysis of Resistance Band Exercise (Group B)

Statistical Parameters	Value/Description	Conclusion
Pretest Mean	(Initial data)	-
Posttest Mean	1.7% higher than the pretest	There was an increase in ability
T-value	11,297	Significant (t count > t table)
T-table Value	2,114	-
Significance (p-value)	0	Very significant (p < 0.05)
Hypothesis	H0 Rejected, H1 Accepted	There was a real difference

Statistical data analysis confirmed that the resistance band training program significantly contributed to improving athletes' overhead serve skills. The results showed an average score increase of 1.7%, which, although seemingly incremental, was statistically highly valid. This was reinforced by a p-value well below the threshold of alpha = 0.05, confirming that the change was not a random result. Therefore, this elastic resistance training method has been scientifically proven effective and is worthy of implementation as a standard protocol in volleyball athlete development programs in school environments to optimize their technical performance.

Hanging Ball Training is More Effective Than Resistance Band Training on Overhand Serve Skills of Extracurricular Volleyball Students

It can be concluded that there is a significant difference in the effect of hanging ball training between Group A and Group B on the overhead serve skills of extracurricular volleyball students at High School 25 Bone. The observed t-value of 3.092 is greater than the t-table of 2.048 (3.092 > 2.048), with significant values of 0.004 < 0.05 and 0.005 < 0.05. Therefore, H0 is rejected and H1 is accepted, meaning there is a significant difference in the effect between the posttest of hanging ball training in Group A and the posttest of resistance band training in Group B. Therefore, it can be concluded that there is a significant difference in the effect between hanging ball training and resistance band training on the upper serve skill in volleyball games of extracurricular volleyball students at High School 25 Bone.

Table 3. Comparison of Posttest Results of Upper Service Skills

Comparison Variable	Group A (Hanging Ball)	Group B (Resistance Band)	Mean Diff
Mean Value	14.27	12.4	1.87
T-value	3.092	-	-
T-table Value	2.048	-	-
Significance (p-value)	0,004 & 0,005	< 0,05	-
Decision Results	H1 Accepted (Significant)	-	-

A comparative analysis of posttest results revealed a significant difference in the improvement of overhead serve skills between the two experimental groups at High School 25 Bone. Quantitatively, group A, which implemented the hanging ball training method, achieved an average score of 14.27, consistently surpassing group B, which used resistance band training, with an average score of 12.40.

This 1.87-point difference in average scores confirms that the hanging ball method intervention had a more optimal impact on students' overhead serve accuracy and technique. Based on these data, it can be concluded that hanging ball training has a competitive advantage over resistance band training in facilitating volleyball skill mastery for extracurricular students.

Discussion

Building upon the results of data analysis and hypothesis testing, this study confirms that interventions using both hanging ball and resistance band training methods significantly contribute to improving the overhead serve skills of extracurricular students at High School 25 Bone. These findings indicate that both weight training and mechanical training models can stimulate the neuromuscular coordination required for overhead serve techniques. To provide a more comprehensive overview of the effectiveness of each method, the following is an in-depth explanation of the findings:

Effect of Hanging Ball Training on Upper Serve Skills

The results showed a significant improvement in the experimental group using the hanging ball training method. This finding was statistically validated by obtaining a calculated t-value of 12.435, which substantially exceeded the t-table value, It was supported by an average score increase of 3.6 points in the posttest. Biomechanically, the effectiveness of hanging ball training lies in providing a consistent focal point during contact between the hand and the ball (impact).

This training allows students to refine their technique repeatedly (repetition) during the contact timing phase without being distracted by the variable toss of the ball, which is often unstable in novice athletes. This consistent repetition, in accordance with motor learning theory, plays a crucial role in the formation of muscle memory and movement automation. By accurately measuring the ball's position at its highest point, students can optimize arm muscle strength precisely, which in turn improves explosive power and serves accuracy.

In line with these findings, the theory proposed by Levac et al. (2019) regarding the transfer of learning states that training that focuses on the consistency of basic movement patterns will accelerate the mastery of complex skills. Furthermore, previous studies Appelbaum and Erickson (2018) emphasize that controlled static weight training methods such as hanging balls are very effective in building a technical foundation for students at the cognitive and associative stages before they move on to more dynamic game situations.

The Effect of Resistance Band Training on Overhead Serve Skills

The experimental group using the resistance band training method also demonstrated significant performance improvements, as evidenced by a t-test value of 11.297. Physiologically, the use of resistance bands works by applying progressive elastic loading to the shoulder joint (glenohumeral) and the arm muscle complex, particularly the deltoid and triceps muscles, during the service swing phase.

This application of loading aligns with the principle of specificity of training, where weight training that mimics the movement patterns of a specific sport will increase explosive power and functional muscle strength during contact with the ball. According to Bompa and Buzzichelli theory on strength periodization, the use of elastic resistance is highly effective in increasing motor unit recruitment in the prime movers, which in this context are the muscles responsible for arm swing speed (Blumenstein & Orbach, 2020; Bompa & Buzzichelli, 2019).

Although statistically significant, the findings of this study indicate that improvements in this group were more focused on physical strengthening and swing speed than on ball contact precision. This explains why, despite the increase in posttest scores, their performance was not as high as that of the hanging ball group. This limitation aligns with previous studies that found that pure strength training without integrated object control (the ball) tends to produce high power output but with less refined accuracy. Thus, resistance bands are very effective as a supplement to improve biomotor skills but require integrated coordination techniques to achieve a perfect serve (Ibrahim, 2022; McHenry & Myers, 2025).

Comparison of Effectiveness: Hanging Ball vs. Resistance Band

A crucial finding in this study confirms that the hanging ball training method is significantly more effective than resistance band training in improving overhead serve skills. This advantage was empirically proven through a significance test with a calculated t-value (3.092) > t-table (2.048) and an average post-test margin of 1.87 points (Group A: 14.27 vs. Group B: 12.40). This substantial difference in performance can be analyzed through several theoretical dimensions.

Hanging ball training has a higher degree of specificity to actual match situations (sport-specific). Referring to Magill & Anderson's theory on contextual interference, training that directly involves a ball facilitates the integration of swing power, eye-hand coordination, and impact point accuracy (Lage et al., 2021; Makaruk et al., 2024). Unlike the isolating nature of resistance bands, hanging ball training works the entire kinetic chain of the serving movement holistically.

While resistance bands are effective in strengthening neuromuscular and shoulder stability, these exercises tend to emphasize purely physical aspects. In contrast, hanging ball techniques combine physical aspects with technical precision. In overhead serve mechanics, the success of the movement is largely determined by the sweet spot, or the accuracy of the hand's contact with the ball. According to a study by Colomar et al. (2022), kinematic accuracy at contact is often a more dominant determinant of serving success than the amount of force generated by the arm muscles.

Another advantage of the hanging ball method lies in the provision of instant sensory and visual feedback (intrinsic feedback). When hitting a suspended ball, students immediately receive information about the direction, vibration, and quality of the ball's contact. This process supports Fitts & Posner's theory of motor learning stages, where rapid feedback accelerates the associative phase and facilitates repetitive self-correction to achieve perfect movement automation (Kee, 2019; Salehi et al., 2021).

Holistically, although both training interventions contributed positively to athlete performance, the results of this study confirm that the hanging ball method produced significantly more optimal results for extracurricular students at the High School 25 Bone. This finding provides a crucial pedagogical indication: for athletes at the beginner level or in the school-age group, the integration of assistive devices that mimic actual game conditions is far more effective than isolated weight training.

The concept of "ball feel," or proprioceptive sensitivity, can explain this difference in effectiveness. Training that directly integrates the ball allows students to hone the synchronization between swing power and the accuracy of hand contact with the ball (timing of impact). Conversely, pure strength training, such as resistance band training, while improving biomotor capacity, often creates technical disconnections if not accompanied by object coordination training.

Therefore, within the framework of school sports training curricula, it is highly recommended that coaches prioritize training methods based on technical-mechanical coordination before moving on to purely physical strengthening programs (pure weight or resistance training). This tiered approach ensures that the student's basic technical foundation is firmly established through proper automation of movement so that future increases in physical strength can be efficiently channeled into powerful and accurate serving performances.

4. CONCLUSION

The application of the hanging ball training method had a significant positive effect on improving volleyball overhead serve skills. This effect was empirically demonstrated by the calculated t-value (12.435), which was greater than the t-table (2.144), and supported by a consistent increase in average scores between the pretest and posttest. The resistance band training also significantly contributed to overhead serve skills. This effect was demonstrated by the calculated t-value (11.297), which exceeded the t-table (2.114), indicating a significant difference in performance before and after the intervention. Furthermore, there was a significant difference in effect between the two methods, with hanging ball training proving more effective than resistance band training. This superiority was evident in the hanging ball group's final (posttest) average score of 14.27, statistically higher than the score of the resistance band group, which was 12.40.

As a recommendation, teachers are advised to prioritize the use of the hanging ball method in routine training programs, especially to hone the accuracy and basic technique of overhead serves in beginner-level athletes. It is hoped that students can carry out disciplined and continuous training to build strong muscle memory,

considering that mastering the upper serve technique requires precise neuromuscular coordination. It is recommended to examine other supporting variables that have the potential to influence the quality of the serve, such as leg muscle strength or eye-hand coordination more specifically. Furthermore, future researchers can apply this method to a wider population or different age groups to strengthen the external validity and generalizability of the research results in the scope of volleyball.

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