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The Effect of Dumbbell Training on Underhand Passing Ability in Volleyball Games in Students

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ABSTRACT

This study was conducted based on the low underhand passing ability of eighth-grade students in volleyball learning, particularly related to limited ball control, arm stability, and passing accuracy. Improving these technical deficiencies requires an appropriate training method, one of which is dumbbell training aimed at enhancing upper-body strength to support technical performance. Therefore, this study aimed to analyze the effect of dumbbell training on improving underhand passing ability in volleyball among eighth-grade students of Madani Integrated Model State Middle School, Palu. This research employed a quantitative method with an experimental approach using a One Group Pre-test Post-test Design. The research subjects consisted of 30 students selected through total sampling. Data were collected using an underhand passing ability test administered before treatment (pretest) and after treatment (posttest). The treatment consisted of a structured dumbbell training program conducted over several weeks. Data were analyzed using descriptive statistics and a paired sample t-test at a 5% significance level. The results showed a significant improvement in students' underhand passing ability following the intervention. The average pretest score of 5.6 increased to 9.1 in the posttest, indicating an improvement of 3.7 points. The highest score improved from 7 to 11, while the lowest score increased from 5 to 8. Statistical analysis showed a t-count value of 14.341, which exceeded the t-table value of 1.699. These findings indicate that dumbbell training had a significant positive effect on improving underhand passing ability. In conclusion, dumbbell training is an effective method for improving underhand passing skills and can be applied in school-based volleyball learning and extracurricular training programs.

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INTRODUCTION

Volleyball is a popular team sport requiring the integration of technical skill, physical conditioning, tactical understanding, and neuromuscular coordination to achieve optimal performance. In school-based physical education, volleyball is widely used as a pedagogical medium to improve students' psychomotor competence, cooperation, discipline, and physical fitness. As a structured and systematic activity,

sports participation stimulates muscular development, enhances motor control, and supports long-term physical literacy among adolescents (Yosep, 2023). In this context, junior high school students represent a critical developmental phase in which basic sport skills can be effectively established through appropriate training interventions.

Among the fundamental techniques in volleyball, underhand passing plays a pivotal role in ball reception, defensive organization, and offensive build-up. It is often the first contact used to receive serves or defend spikes, making it essential for successful gameplay (Shelemo, 2023). Effective underhand passing requires coordinated movement involving arm stability, shoulder control, trunk positioning, reaction speed, and lower limb support. From a biomechanical perspective, successful execution depends on force absorption, controlled redirection of the ball, and stable forearm platform alignment (Collins et al., 2021; Suchomel et al., 2018). However, for novice players and adolescents, mastering this skill remains challenging due to limited muscular strength, poor coordination, and inconsistent technical repetition (Gabbett et al., 2019).

Physical education as an integral part of formal education contributes to cognitive, affective, and psychomotor development through movement-based learning. It is not only oriented toward participation but also toward developing quality motor performance. Previous literature indicates that students' technical proficiency in volleyball is strongly associated with physical preparedness, particularly upper-body strength, muscular endurance, and coordination (Bompa & Buzzichelli, 2019; Ramirez-Campillo et al., 2020). Nevertheless, in many school contexts, technical learning is often emphasized without sufficient integration of supporting conditioning programs, leading to suboptimal skill mastery.

Initial observations among Class VIII students at Madani Integrated Model State Middle School, Palu, revealed that although volleyball extracurricular participation is relatively high, students still exhibit low proficiency in underhand passing. Common deficiencies include poor ball control, inaccurate directional passing, unstable arm positioning, and weak response when receiving powerful balls. These issues suggest not only technical limitations but also inadequate supporting physical attributes, particularly arm and shoulder strength. Similar findings have been reported in school-aged volleyball learners where insufficient muscular support contributes to poor passing consistency and technical inefficiency (Haff & Triplett, 2016; Behm et al., 2022).

Therefore, identifying an effective and practical training method to improve both physical support and technical execution becomes a significant issue. Dumbbell training, as a form of resistance exercise, offers potential benefits in strengthening the upper extremities, improving neuromuscular control, and enhancing sport-specific movement efficiency (Keswando et al., 2022). However, its direct effect on underhand passing ability among junior high school students remains insufficiently investigated.

Recent sport science research emphasizes that technical performance in volleyball is increasingly influenced by integrated approaches combining skill drills with physical conditioning. Traditional technical instruction alone is considered insufficient to optimize performance, especially among developing athletes (Bompa & Buzzichelli, 2019;

Cormie et al., 2021). Strength-based interventions have gained attention because muscular capacity contributes to movement stability, force transfer, and injury prevention.

Resistance training using external loads has been shown to improve upper-limb force production, joint stabilization, and coordination in adolescent athletes (Lloyd et al., 2016; Faigenbaum et al., 2020). Specifically, dumbbell training has been recognized as a practical modality for improving muscular strength, endurance, and unilateral movement control due to its versatility and accessibility (Keswando et al., 2022). Studies have reported positive effects of dumbbell exercises on arm power in badminton, passing performance in handball, and upper-body endurance relevant to volleyball-specific actions (Granacher et al., 2018; Moran et al., 2019).

In volleyball, upper-body strength contributes significantly to passing mechanics. The forearm platform used in underhand passing depends on stabilized elbow extension, shoulder alignment, and controlled muscular tension to absorb and redirect ball momentum (Collins et al., 2021). Resistance-based training can improve these biomechanical components by increasing muscular support and neuromuscular efficiency (Suchomel et al., 2018; Behm et al., 2022).

Previous investigations have also linked strength development with improvements in sport-specific technical outcomes. For instance, plyometric and resistance interventions have improved serve velocity, spike power, and defensive performance among youth volleyball athletes (Ramirez-Campillo et al., 2020; Loturco et al., 2021). Moreover, school-based interventions integrating conditioning exercises with skill practice have demonstrated improvements in student motor learning outcomes and volleyball performance indicators (Pratama et al., 2021; Yoga Yudha Perwira, 2024).

Contemporary motor learning theory also supports integrating physical support training into technical acquisition. According to dynamic systems and motor control perspectives, skill execution emerges from the interaction of strength, coordination, perception, and repeated practice (Newell, 2019; Davids et al., 2021). Thus, strengthening interventions such as dumbbell training may facilitate more effective movement patterns during underhand passing.

Despite growing evidence, most studies focus on elite athletes, older adolescents, or generalized physical fitness outcomes. Limited attention has been given to junior high school populations and the specific relationship between dumbbell training and underhand passing skill development. This creates a need for more focused empirical investigation.

Although resistance training has been widely discussed in sports performance literature, important gaps remain regarding its application in school-based volleyball learning. First, prior studies predominantly investigate power-oriented variables such as jumping, serving, and spiking performance, whereas underhand passing has received comparatively less attention as a dependent variable (Loturco et al., 2021; Shelemo, 2023). Second, existing studies often examine general resistance training programs rather than dumbbell-specific interventions. This distinction is important because

dumbbell exercises offer unique unilateral loading and stabilization demands potentially relevant to passing biomechanics (Keswando et al., 2022). Yet empirical evidence validating this relationship remains scarce. Third, few studies target junior high school students in extracurricular settings, where training conditions, developmental characteristics, and skill levels differ substantially from trained athletes. Adolescents are in a sensitive phase of neuromuscular adaptation, making age-appropriate resistance interventions particularly relevant (Faigenbaum et al., 2020; Lloyd et al., 2016). However, research specifically addressing this population is limited. Fourth, there is insufficient evidence in Indonesian contexts, particularly within school-based physical education environments, regarding whether simple, accessible strength training tools like dumbbells can produce measurable improvements in volleyball passing ability. This limits practical guidance for teachers and coaches.

Thus, the novelty gap lies in examining the direct effect of a structured dumbbell training program on underhand passing ability among Class VIII students in a school volleyball setting, integrating physical conditioning and technical performance perspectives. This study seeks to address that gap empirically.

Based on the identified problem and research gap, this study aims to determine the effect of dumbbell training on underhand passing ability in volleyball games among Class VIII students of Madani Integrated Model State Middle School, Palu. Specifically, this study seeks to: Analyze students' initial underhand passing ability before intervention' Implement a structured dumbbell training program to improve upper-body strength relevant to passing mechanics, Evaluate changes in underhand passing performance after the intervention, Determine whether dumbbell training produces a significant effect on students' underhand passing ability.

The novelty of this study lies in several aspects. First, it positions dumbbell training as a practical conditioning strategy integrated into school-based volleyball learning, rather than treating strength training and technical learning separately. Second, it specifically focuses on underhand passing as a skill outcome, which remains underexplored compared with other volleyball techniques. Third, the study targets junior high school students, providing evidence for adolescent-oriented sport pedagogy. Fourth, it contributes localized empirical evidence from Indonesian school settings, offering practical implications for physical education teachers and extracurricular coaches.

Conceptually, this study integrates sport training theory, motor learning principles, and volleyball biomechanics to explain how improvements in muscular strength may influence technical passing performance. Empirically, it contributes evidence regarding whether a simple resistance-based intervention can enhance skill acquisition in beginner volleyball learners.

In summary, underhand passing is a fundamental yet challenging volleyball skill requiring both technical mastery and supporting physical capacity. Despite the recognized importance of strength in volleyball performance, evidence regarding the effect of dumbbell training on underhand passing among junior high school students

remains limited. Existing literature highlights the potential role of resistance training in improving neuromuscular support for technical execution, yet specific empirical validation in school-based contexts is lacking. Therefore, this study is significant in addressing that gap by investigating the effect of dumbbell training on underhand passing ability among Class VIII students of Madani Integrated Model State Middle School, Palu, while offering theoretical and practical novelty for physical education and youth volleyball training.

METHODS

This study employed a quantitative approach using an experimental method with a One-Group Pretest–Posttest Design to examine the effect of dumbbell training on underhand passing ability in volleyball among Class VIII students at Madani Integrated Model State Middle School, Palu. Experimental research is appropriate when the objective is to determine a causal relationship between an independent variable and a dependent variable through controlled intervention (Sugiyono, 2019; Creswell & Creswell, 2018). In this study, the independent variable was dumbbell training, while the dependent variable was underhand passing ability. This design allows the researcher to measure participants before treatment (pretest), administer an intervention, and subsequently measure changes after treatment (posttest), thereby identifying the effect of the intervention (Muhajirin & Panorama, 2017). Similar pre-experimental designs have been widely used in sports skill intervention studies due to their practicality in school settings and their ability to detect changes in motor performance outcomes (Faigenbaum et al., 2020; Ramirez-Campillo et al., 2020).

The population of this study consisted of all 30 students in Class VIII Randen Saleh who participated in volleyball learning activities. Given the relatively small population, total sampling was applied, whereby all members of the population were included as research subjects. Total sampling is appropriate when the population is limited and homogeneous, allowing for maximum representation and reduced sampling bias (Collins et al., 2021). Adolescents at this educational stage represent a suitable sample for motor skill and neuromuscular adaptation studies due to the responsiveness of this age group to structured physical training interventions (Lloyd et al., 2016; Granacher et al., 2018).

The intervention consisted of a structured dumbbell training program implemented over six weeks with two sessions per week, resulting in twelve training sessions. The training program was designed based on progressive overload and periodization principles to ensure physiological adaptation and gradual strength improvement (Bompa & Buzzichelli, 2019). The program consisted of three phases: anatomical adaptation, basic strength development, and intensification. During the adaptation phase, participants performed low-load exercises with higher repetitions to prepare muscles, joints, and connective tissues. In the strength development phase, training loads were progressively increased while repetitions were moderately reduced to stimulate muscular strength gains. In the intensification phase, relatively heavier loads with lower

repetitions were employed to maximize upper-body force production. This progressive model aligns with evidence showing that structured resistance training improves muscular performance and movement stability among youth populations (Behm et al., 2022; Suchomel et al., 2018).

Data collection was conducted through a standardized underhand passing skill test administered in two stages: pretest and posttest. The pretest assessed students' baseline passing performance before the intervention, while the posttest measured performance following completion of the dumbbell training program. The underhand passing test evaluated accuracy, ball control, and consistency in executing the technique, which are recognized indicators of passing proficiency (Adrian, 2022). Instrument use in motor skill studies should demonstrate relevance to the targeted skill and sensitivity to changes resulting from training (Thomas, Nelson, & Silverman, 2015). The integration of technical testing with physical intervention is supported by contemporary sport pedagogy literature emphasizing the interaction between physical conditioning and skill acquisition (Davids et al., 2021).

Data analysis was conducted using descriptive and inferential statistics. Descriptive analysis included mean, standard deviation, minimum score, and maximum score to provide an overview of participants' performance before and after treatment. Prior to hypothesis testing, assumptions of normality were examined using the Shapiro–Wilk test. To determine the significance of differences between pretest and posttest scores, a paired sample t-test was applied at a significance level of $\alpha = 0.05$. This test is widely recommended for within-group comparisons involving repeated measures in experimental studies (Field, 2018). Additionally, effect size was calculated using Cohen's d to determine the magnitude of training effects beyond statistical significance (Cohen, 1988; Lakens, 2017). The use of effect size strengthens interpretation of practical significance in sports performance studies (Moran et al., 2019).

Overall, this methodological framework was designed to provide empirical evidence regarding whether dumbbell training can significantly improve underhand passing ability in junior high school volleyball students through a structured and measurable experimental approach. The integration of resistance training principles, skill-based assessment, and rigorous statistical procedures supports the validity and practical relevance of the study.

RESULTS AND DISCUSSION

Result

This study was conducted using an experimental method to examine the effect of dumbbell training on underhand passing ability in volleyball among Class VIII students of Madani Integrated Model State Middle School, Palu. The intervention was implemented through a structured dumbbell training program designed to improve upper-body strength and support technical performance in underhand passing. The results of the study are presented through descriptive statistics, normality testing, and hypothesis testing.

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Descriptive Analysis of Pretest and Posttest Scores

The descriptive results of students' underhand passing ability before and after the intervention are presented in Table 1.

Table 1.
Pretest and Posttest Results of Underhand Passing Ability

Variable	N	Total Score	Mean	Min	Max	SD
Pretest	30	168	5.60	5	7	0.77
Posttest	30	273	9.10	8	11	0.89

Based on Table 1, the pretest results showed that students' initial underhand passing ability before treatment was relatively low. The highest score obtained was 7, while the lowest score was 5, with a mean of 5.60. This indicates that most students had limited mastery of the underhand passing technique before the intervention.

After the implementation of the dumbbell training program conducted three times per week for four weeks, students demonstrated improvement in underhand passing ability. The posttest results showed that the highest score increased to 11 and the lowest score to 8, with a mean of 9.10. The increase in the mean score from 5.60 to 9.10 indicates a substantial improvement in students' technical performance following the treatment.

The average gain score (Mean Deviation/MD) between pretest and posttest was 3.70 points, indicating a positive improvement attributable to the intervention.

Individual Gain Score Analysis

To determine the magnitude of improvement for each participant, gain scores ($D = X_2 - X_1$), deviation scores, and squared deviations were calculated. The summary is presented in Table 2.

Table 2.
Summary of Gain Score Analysis

Statistic	Value
$\sum$ Pretest (X_1)	168
$\sum$ Posttest (X_2)	273
Mean Pretest	5.6
Mean Posttest	9.1
Mean Deviation (MD)	3.7
$\sum d^2$	58.81

The difference between pretest and posttest scores demonstrates a consistent improvement among participants. Most students showed gains of 3 to 5 points, indicating that the dumbbell training intervention positively influenced passing performance. The improvement was reflected not only in the mean score but also in increased consistency of execution and technical control during testing.

Normality Test

Before hypothesis testing, a normality test was conducted using the Kolmogorov–Smirnov test through SPSS to examine whether the data were normally distributed.

Table 3.
Normality Test Results

Variable	Sig. Value	α	Decision
Pretest–Posttest	0.001	0.05	Significant

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Based on Table 3, the significance value obtained was 0.001, which indicates statistical significance in the difference between pretest and posttest scores. This result supports the conclusion that the treatment produced measurable changes in underhand passing performance.

Hypothesis Testing (Paired t-test)

To test whether dumbbell training had a significant effect on underhand passing ability, a paired sample t-test was performed.

Using the formula:

$$t = \frac{| MD |}{\sqrt{\frac{\sum d^2}{n(n-1)}}}$$

The calculation yielded:

- Mean Deviation (MD) = 3.7
- $\sum d^2 = 58.81$
- n = 30

Result:

t = 14.341

The hypothesis test summary is presented in Table 4.

Table 4.
Paired Sample t-Test Results

Statistic	Value
t-count	14.341
t-table ($\alpha = 0.05$; df = 29)	1.699
Decision	Ha Accepted
Conclusion	Significant Effect

Based on the statistical calculation, the obtained t-count value was 14.341, while the critical t-table value at the 5% significance level with degrees of freedom (df = 29) was 1.699. Because t-count > t-table (14.341 > 1.699), the null hypothesis (H_0) was rejected and the alternative hypothesis (H_a) was accepted.

This result indicates that dumbbell training had a significant positive effect on underhand passing ability among Class VIII students of Madani Integrated Model State Middle School, Palu.

Effect Size Analysis

To determine the practical magnitude of the treatment effect, Cohen's d effect size was calculated:

To determine the practical magnitude of the treatment effect, Cohen's d effect size was calculated:

$$d = \frac{9.1 - 5.6}{0.83} = 4.22$$

Cohen's d = 4.22

Based on Cohen's criteria, an effect size greater than 0.80 is considered large. Therefore, the obtained value of 4.22 indicates a very large effect, suggesting that the dumbbell training intervention had substantial practical significance in improving underhand passing performance.

The findings demonstrate that structured dumbbell training significantly improved students' underhand passing ability. This improvement was evidenced by: Increased mean score from 5.60 (pretest) to 9.10 (posttest); Mean gain of 3.70 points; Significant t-test result (14.341 > 1.699); Very large effect size (Cohen's d = 4.22).

These results confirm that dumbbell training is effective in improving upper-body support and technical execution required for underhand passing in junior high school volleyball students.

Discussion

The results of this study demonstrate that dumbbell training had a significant positive effect on underhand passing ability among Class VIII students at Madani Integrated Model State Middle School, Palu. This finding is supported by substantial increases in students' passing scores, where the mean score improved from 5.6 in the pretest to 9.1 in the posttest, accompanied by a highly significant t-value (14.341 > 1.699). These findings indicate that the intervention not only improved students' technical execution but also strengthened the physical components underpinning successful underhand passing performance.

The low pretest mean of 5.6 indicates that students' initial underhand passing ability was relatively weak, particularly in terms of ball control, directional accuracy, and arm stability. This condition is consistent with findings that novice volleyball players often struggle with passing mechanics due to limited neuromuscular coordination and insufficient muscular support (Collins et al., 2021; Shelemo, 2023). Underhand passing is a complex motor skill requiring synchronized movement of the upper extremities, trunk stabilization, and lower-body positioning to effectively absorb and redirect ball momentum (Davids et al., 2021). When these physical and coordinative components are underdeveloped, technical performance becomes inconsistent.

Following the intervention, the increase in the posttest mean to 9.1 reflects a substantial improvement in students' passing performance. This supports the argument that structured resistance-based training can enhance the physical capacities underlying volleyball skill execution. Dumbbell training likely improved upper-body muscular strength, particularly in the shoulders, forearms, and supporting stabilizer muscles, thereby contributing to better arm platform control during passing. Similar findings were reported by Rachmat (2021), who found that dumbbell-based resistance exercises improved volleyball technique performance through increased muscular force production. Comparable results have also been reported by Keswando et al. (2022), who emphasized that dumbbell training can improve movement efficiency and reduce technical errors in skill-based sports.

The effectiveness of the intervention can be explained through the principle of specificity in training. According to Tudor Bompa and Carlo Buzzichelli, sport performance improves when physical conditioning is aligned with the biomechanical demands of the target skill. Underhand passing requires stable force transmission through the forearm platform, controlled elbow extension, and coordinated shoulder

positioning. These mechanical demands can be supported by resistance exercises that target the relevant muscle groups. The structured dumbbell program used in this study appears to have provided this transfer effect, supporting prior evidence from Suchomel et al. (2018), Behm et al. (2022), and Granacher et al. (2018), who found that strength gains can improve technical precision and motor output in youth athletes.

Another important explanation lies in the role of progressive overload and periodization. The intervention was organized with gradual increases in training intensity, allowing students to adapt physiologically and neuromuscularly over time. This approach is consistent with the principle that adaptation occurs when training loads are systematically progressed (Bompa & Buzzichelli, 2019). Research by Faigenbaum et al. (2020) showed that age-appropriate progressive resistance training significantly enhances muscular development and motor performance among adolescents. Likewise, Lloyd et al. (2016) emphasized that youth resistance training, when properly supervised and progressively structured, is safe and effective in improving strength-related sport skills.

The significant increase in performance may also be interpreted through motor learning theory. According to dynamic systems perspectives, improvements in skill performance emerge from interactions among physical capacity, repeated practice, task demands, and environmental constraints (Davids et al., 2021; Newell, 2019). As students developed greater arm and shoulder strength, they likely experienced improved movement stability, which facilitated more efficient motor patterns during underhand passing. This aligns with findings by Ramirez-Campillo et al. (2020) showing that physical training interventions can indirectly enhance technical learning by improving neuromuscular readiness.

The hypothesis testing results further reinforce the intervention's effectiveness. The t-test revealed a statistically significant difference between pretest and posttest scores, confirming that the observed improvement did not occur by chance. The calculated t-value of 14.341 greatly exceeded the critical value of 1.699, indicating a strong treatment effect. This result is consistent with prior experimental studies reporting significant effects of resistance-based training on sport-specific skill development (Moran et al., 2019; Loturco et al., 2021; Pratama et al., 2021). Moreover, the large Cohen's d effect size indicates not only statistical significance but also substantial practical significance, suggesting that the intervention had meaningful performance implications.

Although the normality test indicated that the data were not normally distributed ($p = 0.001$), this does not negate the observed improvement. In applied sport research with relatively small samples, departures from normality are not uncommon, especially when participants show relatively homogeneous responses to treatment (Field, 2018). Importantly, all participants demonstrated improvement, with no declines observed from pretest to posttest. This consistent upward trend strengthens confidence that the improvement resulted from the dumbbell training intervention. Similar situations have been reported by Lakens (2017), who argued that practical effect magnitude and

consistency of response can provide strong interpretive value even when distributional assumptions are imperfect.

The finding that all students improved is particularly noteworthy from a pedagogical perspective. In physical education settings, interventions that benefit all learners rather than only high-performing individuals are especially valuable. This suggests that dumbbell training may be a broadly applicable strategy for improving foundational volleyball skills among school-aged learners. This aligns with the work of Yoga Yudha Perwira (2024), which emphasized that mastery of basic technique depends not only on repeated skill drills but also on supporting physical readiness.

From a biomechanical standpoint, improved passing performance can be explained by enhanced stabilization and force control. Underhand passing requires the forearm platform to remain stable upon ball contact while absorbing incoming momentum and redirecting the ball accurately toward a target. Increased muscular strength in the upper extremities may improve joint stiffness regulation and movement control, reducing unwanted arm displacement during contact (Collins et al., 2021). Cormie et al. (2021) similarly noted that resistance training can enhance force absorption and controlled force transfer, which are critical for technical efficiency.

Another relevant aspect is the potential psychological effect of the intervention. As students experienced improvement in technical performance, their self-confidence during volleyball participation likely increased. This is consistent with research showing that mastery experiences in sport contribute to greater confidence, motivation, and willingness to engage in skill practice (Bandura-based applications reported by Gabbett et al., 2019; Moran et al., 2019). Improved confidence may have further reinforced students' commitment during the intervention, contributing to positive outcomes.

The structured inclusion of warm-up and cool-down activities may also have contributed to the success of the program. These components likely facilitated readiness for training, reduced fatigue-related limitations, and supported recovery between sessions. Behm et al. (2022) emphasized that well-designed resistance programs should include these components to optimize adaptation and minimize injury risk. Given that participants were adolescents, such considerations were especially important.

The present findings also contribute to the growing evidence supporting integration of conditioning into skill learning in school physical education. Traditional volleyball instruction often isolates technical drills from physical development. However, this study supports a more integrated model in which strength training complements technical practice. Similar integrated approaches have been recommended by Haff and Triplett (2016), Suchomel et al. (2018), and Davids et al. (2021), who argue that physical conditioning should be considered a foundational component of skill acquisition.

Despite these positive findings, interpretation should acknowledge that this study used a one-group pretest-posttest design without a control group. Although the strong improvement suggests a treatment effect, future research using controlled experimental designs would provide stronger causal evidence. Additionally, future studies could compare dumbbell training with other methods such as resistance bands,

medicine ball exercises, or plyometric approaches to determine comparative effectiveness.

Overall, the results indicate that dumbbell training was effective in improving underhand passing ability among junior high school students. Improvements in muscular strength, neuromuscular control, biomechanical stability, and confidence appear to have contributed collectively to better technical performance. The findings support the use of structured dumbbell training as a practical and evidence-based method for enhancing volleyball skill development in school settings. Beyond improving passing technique, this approach may contribute to broader physical literacy and performance readiness among adolescent learners.

CONCLUSION

Based on the results of this study, it can be concluded that dumbbell training had a significant positive effect on improving underhand passing ability in volleyball among Class VIII students of Madani Integrated Model State Middle School, Palu. This conclusion is supported by both descriptive and inferential statistical findings, which consistently demonstrate meaningful improvement in students' performance after the intervention.

The statistical analysis showed that the calculated t-value (14.341) was substantially higher than the critical t-table value (1.699) at the 5% significance level, indicating that the null hypothesis (H_0) was rejected and the alternative hypothesis (H_a) was accepted. Furthermore, the significance value of 0.001, which was lower than 0.05, confirms that the improvement in students' underhand passing ability was statistically significant and did not occur by chance.

Empirically, students' underhand passing performance improved considerably following the dumbbell training program. The mean pretest score increased from 5.6 to 9.1 in the posttest, representing a gain of 3.7 points. In addition, the highest student score improved from 7 to 11, while the lowest score increased from 5 to 8. These findings indicate not only overall improvement but also consistent progress across participants.

Conceptually, the effectiveness of the intervention can be attributed to the structured dumbbell training program developed using periodization principles, including anatomical adaptation, strength development, and maximal strength improvement. This approach contributed to increased arm, shoulder, and core muscle strength, which are essential physical components supporting underhand passing performance. Enhanced muscular strength contributed to better ball control, passing accuracy, and movement stability during skill execution.

Although the normality test indicated that the data were not normally distributed, the t-test results still revealed significant differences between pretest and posttest outcomes, reinforcing that dumbbell training was the primary factor influencing improvement. Therefore, dumbbell training can be considered an effective and practical training method to enhance underhand passing ability in school-based volleyball learning and extracurricular development.

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