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The Effect Of Dumbbell Over Head Exercises On Smash Hit Ability In Badminton Games

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ABSTRACT

Badminton is a dynamic sport that requires excellent physical and technical abilities, particularly in executing the smash, which is one of the most effective offensive strokes for scoring points. However, many students still exhibit limited smash ability due to inadequate upper-body strength and power. This study aimed to determine the effect of dumbbell overhead exercises on badminton smash-hit ability among students of SMK Negeri 6 Makassar. The study employed a quantitative experimental method using a pretest-posttest control group design. The population consisted of 40 male students participating in badminton extracurricular activities, with 20 students selected as samples and randomly assigned to experimental and control groups, each comprising 10 participants. The experimental group received dumbbell overhead training, whereas the control group followed conventional badminton practice. Data were analyzed using descriptive statistics, normality and homogeneity tests, paired-sample t-tests, and independent-sample t-tests at a significance level of 0.05. The results showed that the experimental group improved significantly from a pre-test mean score of 10.70 to a post-test mean score of 16.80, with a mean difference of 6.10 points ($t = 22.031$; $p < 0.05$). Meanwhile, the control group increased from 10.70 to 12.90, with a mean difference of 2.20 points ($t = 7.571$; $p < 0.05$). Furthermore, a significant difference was found between the two groups in the post-test ($t = 3.847$; $p < 0.05$). In conclusion, dumbbell overhead exercises are more effective than conventional training in improving badminton smash-hit ability among vocational high school students.

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INTRODUCTION

Badminton is a dynamic racket sport characterized by rapid and multidirectional movements that require a combination of physical and technical abilities, including strength, speed, agility, endurance, power, reaction time, and coordination. Players are expected to perform explosive movements such as jumping, sprinting, lunging, and changing directions rapidly while maintaining precision in stroke execution. Consequently, mastering badminton skills demands not only technical proficiency but also excellent physical conditioning that supports movement efficiency and stroke performance (Sudiadharma & Ishak, 2020).

In Indonesia, badminton has become one of the most popular and successful sports, as evidenced by the increasing number of clubs, tournaments, and talented young athletes emerging at

regional and national levels. This development requires schools and coaches to design training programs capable of improving students' technical and physical abilities simultaneously. Basic badminton techniques consist of grip, ready stance, footwork, and various strokes such as serve, netting, drive, lob, and smash. Among these techniques, the smash is considered the most aggressive and decisive offensive stroke because it enables players to penetrate opponents' defenses and score points directly (Gusrinaldi et al., 2020).

The execution of a successful smash requires an integrated movement involving the lower limbs, trunk rotation, shoulder complex, elbow extension, wrist flexion, and racket acceleration. Therefore, the quality of smash performance is highly influenced by upper-body muscular strength and power, particularly in the shoulder and arm muscles (Phomsoupha & Laffaye, 2015). Recent biomechanical studies have shown that greater shoulder strength and explosive upper-body actions contribute significantly to shuttlecock velocity and smash accuracy (Abian-Vicen et al., 2020; Valldecabres et al., 2022). However, many adolescent badminton players still demonstrate insufficient smash power due to limited arm strength and inadequate resistance training programs (Rachmadian, 2021).

Preliminary observations at SMK Negeri 6 Makassar indicate that students participating in badminton extracurricular activities exhibit varying levels of smash ability. Although the school has adequate facilities and a considerable number of students involved in badminton, many students still struggle to produce powerful and accurate smashes. These limitations are often associated with insufficient upper-body strength and the lack of specific resistance exercises integrated into their training program. Therefore, identifying effective training methods to improve smash performance is an important issue for badminton coaching and physical education in vocational schools.

The development of badminton performance is strongly associated with scientifically designed training programs that integrate technical and physical components. Contemporary sports science emphasizes that resistance training is an effective approach for enhancing muscular strength, power, and sport-specific performance among adolescent athletes (Suchomel et al., 2018; Cormie et al., 2022). Specifically, upper-body resistance exercises have been shown to improve racket sports performance by increasing force production and movement velocity (Fernández-Fernández et al., 2019).

Dumbbell training is one of the most widely used resistance-training modalities because it allows unilateral and bilateral movements that closely resemble sport-specific actions. Among various dumbbell exercises, the dumbbell overhead exercise is particularly relevant to badminton because it targets the deltoids, triceps brachii, trapezius, and stabilizing muscles involved in overhead strokes (Schoenfeld & Grgic, 2018). Research has demonstrated that overhead resistance exercises significantly improve shoulder strength, upper-limb power, and throwing performance in young athletes (Comfort et al., 2019; Loturco et al., 2021).

In racket sports, resistance training has been associated with improvements in stroke speed and performance. For example, Fernández-Fernández et al. (2018) reported that upper-body strength training enhanced serve velocity in tennis players. Similarly, Siahkouhian et al. (2020) found that resistance exercises increased smash speed and upper-limb power among adolescent badminton players. Studies conducted in Asian contexts also reported that arm strength is positively correlated with badminton smash performance, indicating that stronger upper extremity muscles contribute to greater shuttlecock speed and more effective attacking strokes (Benovri, 2018; Munizar et al., 2019).

Recent investigations have increasingly focused on integrating resistance exercises with sport-specific movements. According to Chaabene et al. (2019), combining strength exercises with technical training produces superior outcomes compared with conventional technical drills alone. Moreover, resistance exercises using free weights are considered more effective in improving functional strength because they require neuromuscular coordination and stabilization similar to actual sporting movements (Schoenfeld et al., 2021). Consequently, dumbbell overhead exercises have the potential to enhance badminton smash ability by simultaneously increasing muscular strength and movement specificity.

Although numerous studies have examined the relationship between muscular strength and badminton performance, several limitations remain. First, previous studies have primarily focused on elite athletes or university players, whereas research involving vocational high school students remains

limited (Chaabene et al., 2019; Valldecabres et al., 2022). Adolescents in vocational schools have different physical characteristics, training experiences, and learning environments that may influence the effectiveness of resistance-training interventions.

Second, most previous investigations have employed general resistance exercises such as push-ups, medicine ball throws, or circuit training to improve badminton performance (Munizar et al., 2019; Benovri, 2018). Limited attention has been given to dumbbell overhead exercises, despite their biomechanical similarity to overhead badminton strokes. Therefore, empirical evidence regarding the effectiveness of this exercise for improving smash ability remains insufficient.

Third, studies conducted in Indonesian educational settings have predominantly examined technical drills and game-based learning approaches rather than resistance-training interventions that specifically target upper-body strength (Gusrinaldi et al., 2020; Rachmadian, 2021). Consequently, there is a need for experimental research investigating whether dumbbell overhead exercises can significantly improve smash ability among vocational school students. This study addresses these gaps by examining the effect of dumbbell overhead exercises on badminton smash ability in students of SMK Negeri 6 Makassar. The findings are expected to contribute to evidence-based badminton coaching and enrich the literature on resistance training in school-based sports settings.

Based on the aforementioned issues, this study aims to determine the effect of dumbbell overhead exercises on the smash-hit ability of badminton players among students of SMK Negeri 6 Makassar. Specifically, this study investigates whether a structured dumbbell overhead training program can significantly improve students' smash performance compared with their initial abilities. The novelty of this research lies in three aspects. First, it focuses on vocational high school students, a population that has received relatively little attention in badminton resistance-training research. Second, the study employs dumbbell overhead exercises as a sport-specific resistance-training intervention that closely resembles the biomechanics of badminton smash movements. Third, this research integrates concepts of strength training and technical performance within a school sports context, thereby providing practical implications for coaches and physical education teachers in designing evidence-based badminton training programs.

In conclusion, badminton smash ability is not solely determined by technical skills but is also strongly influenced by upper-body muscular strength and power. Given the limited empirical evidence concerning dumbbell overhead exercises among vocational school students, this study offers an important contribution to badminton coaching science by exploring an innovative and practical training approach to improve smash performance in adolescent players.

METHODS

This study employed a quantitative experimental approach to examine the effect of dumbbell overhead exercises on badminton smash-hit ability among students of SMK Negeri 6 Makassar. Experimental research is considered an effective method for investigating causal relationships by manipulating an independent variable and observing its effects on a dependent variable under controlled conditions (Creswell & Creswell, 2018). The present study utilized a pretest-posttest control group design, which enables researchers to compare participants' performance before and after treatment while controlling for external influences (Thomas et al., 2022).

The study involved two variables: the dumbbell overhead exercise as the independent variable and badminton smash-hit ability as the dependent variable. The research design consisted of two groups: an experimental group receiving dumbbell overhead training and a control group following conventional badminton practice without additional resistance exercises. Both groups completed pretest and posttest assessments to evaluate changes in smash performance. Such designs are widely recommended in sports science because they provide stronger internal validity and allow accurate measurement of training effects (Chaabene et al., 2019; Grgic et al., 2020).

The population consisted of all male students participating in the badminton extracurricular program at SMK Negeri 6 Makassar, totaling 40 students. According to Junaidi and Susanti (2019), a population comprises individuals sharing common characteristics and serving as the object of investigation. Since the population size was relatively small, all eligible participants were included in

the study through total sampling. Participants were then randomly assigned to either the experimental or control group to minimize selection bias and ensure group equivalence (Creswell & Creswell, 2018).

The intervention program consisted of structured dumbbell overhead exercises performed over several weeks, emphasizing shoulder and arm muscle strength development. Previous studies have demonstrated that overhead resistance exercises effectively improve upper-limb power, neuromuscular coordination, and sport-specific performance in overhead sports (Schoenfeld & Grgic, 2018; Comfort et al., 2019; Loturco et al., 2021). In badminton, upper-body strength has been identified as a key determinant of smash velocity and stroke effectiveness (Fernández-Fernández et al., 2019; Valldecabres et al., 2022). Therefore, the dumbbell overhead exercise was selected because of its biomechanical similarity to the badminton smash movement.

Smash-hit ability was measured using a standardized badminton smash test assessing accuracy and power. Data were analyzed using descriptive statistics and inferential statistics. Normality and homogeneity tests were conducted prior to hypothesis testing, followed by a paired-sample t-test and an independent-sample t-test to determine the significance of training effects at a significance level of $\alpha = 0.05$. This analytical approach is commonly used in experimental sports studies to evaluate pretest-posttest differences and compare intervention outcomes between groups (Suchomel et al., 2018; Cormie et al., 2022).

RESULTS AND DISCUSSION

Result

Descriptive Statistics of Smash-Hit Ability

The descriptive statistics of badminton smash-hit ability for both the experimental group (dumbbell overhead exercise) and the control group are presented in Table 1. The results indicate that students who participated in the dumbbell overhead training program demonstrated a greater improvement in smash performance compared to those in the control group.

Table 1.
Descriptive Statistics of Smash-Hit Ability

Variable	N	Range	Min	Max	Sum	Mean	SD
Experimental Group (Pre-test)	10	6.00	8.00	14.00	107.00	10.70	1.89
Experimental Group (Post-test)	10	6.00	14.00	20.00	168.00	16.80	2.04
Control Group (Pre-test)	10	6.00	8.00	14.00	107.00	10.70	2.26
Control Group (Post-test)	10	7.00	10.00	17.00	129.00	12.90	2.47

The experimental group showed an increase in the mean score from 10.70 ± 1.89 in the pre-test to 16.80 ± 2.04 in the post-test, representing an average improvement of 6.10 points. Meanwhile, the control group increased from 10.70 ± 2.26 to 12.90 ± 2.47, with an average improvement of only 2.20 points. These findings suggest that the dumbbell overhead exercise contributed positively to the improvement of badminton smash-hit ability.

Normality and Homogeneity Tests

Before hypothesis testing, normality and homogeneity assumptions were examined. The Kolmogorov–Smirnov and Shapiro–Wilk tests showed that all variables were normally distributed because the significance values were greater than 0.05.

Table 2.
Results of Normality Test

Variable	Kolmogorov–Smirnov	Sig.	Shapiro–Wilk	Sig.	α	Decision
Dumbbell Overhead Exercise	0.145	0.200	0.964	0.835	0.05	Normal
Control Group	0.174	0.200	0.907	0.263	0.05	Normal

The results indicated that both groups fulfilled the normality assumption because all significance values exceeded 0.05.

The homogeneity test using Levene's Statistic showed a significance value of 0.403 (> 0.05), indicating that the variances of both groups were homogeneous.

Table 3.
Results of Homogeneity Test

Variables	Levene Statistic	Sig.	α	Decision
Experimental and Control Groups	0.735	0.403	0.05	Homogeneous

Effect of Dumbbell Overhead Exercise on Smash-Hit Ability

The paired-sample t-test was used to determine whether there was a significant difference between the pre-test and post-test scores in the experimental group.

Table 4.
Paired Sample t-Test for Experimental Group

Variable	Mean	Mean Difference	t	df	Sig. (2-tailed)	t-table
Post-test	16.80	6.10	22.031	9	0.000	1.833
Pre-test	10.70					

The results showed that the calculated t-value (22.031) was higher than the critical t-value (1.833), with a significance level of 0.000 (< 0.05). Therefore, the null hypothesis (H_0) was rejected, indicating that dumbbell overhead exercise had a significant effect on badminton smash-hit ability among students of SMK Negeri 6 Makassar. The average improvement achieved by the experimental group was 6.10 points.

Improvement in the Control Group

The paired-sample t-test was also performed for the control group.

Table 5.
Paired Sample t-Test for Control Group

Variable	Mean	Mean Difference	t	df	Sig. (2-tailed)	t-table
Post-test	12.90	2.20	7.571	9	0.000	1.833
Pre-test	10.70					

The control group also showed a significant improvement ($t = 7.571$, $p < 0.05$). However, the mean increase of 2.20 points was considerably lower than that of the experimental group, suggesting that regular badminton practice alone was less effective in enhancing smash ability compared to the dumbbell overhead exercise program.

Comparison Between Experimental and Control Groups

An independent-sample t-test was conducted to compare post-test scores between the experimental and control groups.

Table 6.
Independent Sample t-Test Between Groups

Variable	Mean	Mean Difference	t	df	Sig. (2-tailed)	t-table
Experimental Group	16.80	3.90	3.847	18	0.001	2.093
Control Group	12.90					

The results revealed a statistically significant difference between the two groups ($t = 3.847 > 2.093$; $p = 0.001 < 0.05$). The experimental group achieved a higher post-test mean score (16.80) than the control group (12.90), with a mean difference of 3.90 points. These findings indicate that the dumbbell overhead exercise was more effective than conventional training in improving badminton smash-hit ability among students of SMK Negeri 6 Makassar. Therefore, the alternative hypothesis was accepted, confirming that dumbbell overhead exercises significantly enhance smash performance in badminton.

Discussion

The findings of this study demonstrate that dumbbell overhead exercises had a significant effect on improving badminton smash-hit ability among students of SMK Negeri 6 Makassar. The experimental group showed an increase from a pre-test mean score of 10.70 to a post-test mean score of 16.80, with a mean difference of 6.10 points. The paired-sample t-test showed a significant value of p = 0.000, indicating that the improvement was statistically meaningful. This result confirms that structured dumbbell overhead training can enhance the physical components required for an effective badminton smash, particularly shoulder strength, arm power, joint stability, and overhead movement coordination.

Conceptually, the badminton smash is an explosive overhead stroke that requires a coordinated kinetic chain involving the legs, trunk, shoulder, elbow, wrist, and racket acceleration. Phomsoupha and Laffaye (2015) explain that badminton performance depends on the interaction between technical efficiency, physical fitness, and rapid neuromuscular control. In this context, the dumbbell overhead exercise is highly relevant because it trains the muscles directly involved in overhead hitting actions, especially the deltoid, triceps brachii, trapezius, rotator cuff, and scapular stabilizers. Similar findings were reported by Suchomel et al. (2018), who emphasized that muscular strength is a fundamental factor supporting power production and sport-specific performance. Cormie et al. (2022) also stated that resistance training contributes to improved force development, movement velocity, and explosive action in athletic tasks.

The significant improvement in the experimental group supports previous empirical studies showing that upper-body strength training improves racket-sport performance. Fernández-Fernández et al. (2018) found that resistance training improved stroke velocity in tennis athletes, while Valldecabres et al. (2022) highlighted that overhead stroke performance in badminton is strongly influenced by shoulder mechanics and upper-limb power. In Indonesian badminton contexts, Sudiadharma and Ishak (2020), Gusrinaldi et al. (2020), Munizar et al. (2019), Benovri (2018), and Rachmadian (2021) similarly reported that arm strength, technical control, and repeated stroke practice contribute to better smash performance. Therefore, the present result strengthens both international and national evidence that physical conditioning should be integrated into badminton skill training.

The control group also showed a significant improvement, increasing from a pre-test mean score of 10.70 to a post-test mean score of 12.90, with a mean difference of 2.20 points. This finding indicates that conventional badminton practice still provides a positive training effect. The improvement may have occurred because students continued to perform technical drills, repeated hitting actions, and regular badminton movements during the learning process. According to Faude et al. (2015), repeated technical exposure in badminton can improve movement familiarity, timing, and stroke consistency. Similarly, Irawan et al. (2020), Yuliawan and Sugiyanto (2021), Subarkah and Marani (2020), and Putra et al. (2022) found that systematic practice, feedback, and motor repetition can increase basic badminton skill performance among students. However, the smaller improvement in the control group shows that technical practice alone is not sufficient to produce optimal smash power when it is not supported by specific strength training.

The comparison between groups provides the strongest evidence for the effectiveness of the intervention. The independent-sample t-test showed that the experimental group obtained a higher post-test mean score of 16.80 compared with the control group's 12.90, with a mean difference of 3.90 points and a significance value of p = 0.001. This result means that dumbbell overhead training was more effective than conventional practice in improving badminton smash-hit ability. The superiority of the experimental group can be explained through the principle of training specificity. Schoenfeld and Grgic (2018) argue that resistance exercises produce greater performance transfer when the movement pattern, muscle involvement, and force direction are similar to the target sport skill. Because the dumbbell overhead exercise resembles the upward and overhead arm action used in badminton smash execution, it likely produced a direct transfer to hitting performance.

From a physiological perspective, dumbbell overhead training increases muscular strength and neuromuscular recruitment. Comfort et al. (2019) and Loturco et al. (2021) reported that overhead

resistance training improves upper-limb force output, joint stabilization, and explosive power. In badminton, these adaptations are important because smash performance requires rapid force production within a very short time. Chaabene et al. (2019), Granacher et al. (2016), Lesinski et al. (2016), Moran et al. (2017), and Hammami et al. (2018) also confirmed that resistance training in youth athletes can safely improve strength, power, coordination, and sport-specific skills when applied with appropriate load and supervision. This supports the use of dumbbell overhead exercises for vocational school students as long as the program is progressive, controlled, and technically correct.

The present findings also align with motor learning theory. Repeated dumbbell overhead movements may improve students' awareness of arm position, shoulder control, and follow-through mechanics. According to Schmidt and Lee (2019), repeated practice strengthens motor patterns and improves movement consistency. In badminton smash execution, better motor coordination allows students to strike the shuttlecock at a higher contact point and generate a sharper downward trajectory. Studies by Huang et al. (2016), Sakurai and Ohtsuki (2017), Kuntze et al. (2016), Hussain et al. (2018), and Zhao et al. (2021) also indicate that effective overhead strokes depend on timing, body coordination, racket velocity, and efficient transfer of force from the proximal to distal segments.

Practically, these results provide important implications for physical education teachers and badminton coaches at SMK Negeri 6 Makassar. Dumbbell overhead exercises can be used as a simple, practical, and low-cost training method to improve students' smash ability. The exercise does not require complex equipment and can be implemented in school-based extracurricular programs. However, training must consider students' age, initial strength level, exercise technique, load progression, and recovery time to avoid injury risk. Lloyd et al. (2016), Behm et al. (2017), and Myer et al. (2016) emphasized that youth resistance training is beneficial when supervised properly and adapted to the athlete's maturity and technical ability.

Overall, this study confirms that dumbbell overhead exercise significantly improves badminton smash-hit ability in students of SMK Negeri 6 Makassar. Although the control group also improved, the experimental group achieved a much greater increase, proving that specific upper-body resistance training provides stronger performance benefits than conventional practice alone. Therefore, dumbbell overhead exercise is recommended as an evidence-based training strategy for enhancing smash performance in school badminton programs.

CONCLUSION

This study concludes that dumbbell overhead exercises have a significant positive effect on badminton smash-hit ability among students of SMK Negeri 6 Makassar. The experimental group demonstrated a substantial improvement, with the mean score increasing from 10.70 in the pre-test to 16.80 in the post-test, resulting in a mean difference of 6.10 points. Statistical analysis using the paired-sample t-test revealed a significant effect ($t = 22.031$; $p < 0.05$), indicating that dumbbell overhead training effectively enhances smash performance. Conversely, the control group also experienced improvement, increasing from a mean score of 10.70 to 12.90, with a mean difference of 2.20 points ($t = 7.571$; $p < 0.05$), although the improvement was considerably lower than that of the experimental group. Furthermore, the independent-sample t-test demonstrated a significant difference between the two groups ($t = 3.847$; $p < 0.05$), with the experimental group outperforming the control group by 3.90 points in the post-test. Conceptually, these findings confirm that specific upper-body resistance training, particularly dumbbell overhead exercises, contributes to greater muscular strength, explosive power, and neuromuscular coordination required for effective smash execution. Therefore, dumbbell overhead exercises are recommended as an evidence-based training method for improving badminton smash ability in vocational school students and may serve as a practical reference for coaches and physical education teachers in designing school-based badminton training programs.

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