Training Intervention Using Sit-Up and Bent Arm Full Over Methods to Improve Lob Shot Execution in Badminton Athletes

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ABSTRACT

This study investigated the effectiveness of a training intervention using sit-up and bent arm full-over methods to improve lob shot execution in badminton athletes at PKO FIKK UNM. A quasi-experimental design with pre-test and post-test control group was employed, involving 20 active badminton athletes divided equally into experimental and control groups. The intervention lasted 6 weeks, with 3-4 training sessions per week focusing on core and shoulder muscle strengthening exercises. Results showed a significant improvement in the experimental group's lob shot performance. The mean post-test score increased from 70.3 (SD = 5.1) to 85.4 (SD = 4.2), with a paired sample t-test confirming the change as statistically significant ($t(9) = 8.72$, $p < 0.001$). Conversely, the control group's scores showed no significant change (pre-test Mean = 69.8, SD = 4.9; post-test Mean = 71.0, SD = 5.3; $t(9) = 1.12$, $p = 0.29$). Independent sample t-tests between groups showed a significant difference in post-test results favouring the experimental group ($t(18) = 6.04$, $p < 0.001$). The effect size (Cohen's d = 1.91) indicated a large practical impact of the training intervention. This study supports the integration of sit-up and bent arm full-over exercises into badminton training programs to enhance lob shot technique through improved muscular strength and control. Future research is recommended to explore long-term effects and applicability to other badminton skills.

AUTHORS' CONTRIBUTION

A. Conception and design of the study;
B. Acquisition of data;
C. Analysis and interpretation of data;
D. Manuscript preparation;
E. Obtaining funding

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INTRODUCTION

Badminton is a dynamic racket sport that demands a combination of technical skill, physical fitness, and strategic acumen. Among the array of shots utilized in badminton, the lob shot holds particular significance. It serves as a defensive manoeuvre to reposition the opponent and create opportunities for offensive play. Executing an effective lob shot requires precise timing, control, and adequate physical conditioning, particularly in the core and upper body regions.

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The physical demands of badminton necessitate comprehensive training regimens that enhance players' strength, agility, and endurance. Core strength training (CST) has been identified as a crucial component in improving athletic performance across various sports, including badminton. CST focuses on strengthening the muscles of the abdomen, lower back, and pelvis, which are essential for maintaining stability and generating power during dynamic movements. Studies have demonstrated that CST can positively impact muscle power, stability, balance, and skill execution in badminton players.

In the context of badminton, specific training interventions targeting core and upper body strength can enhance the execution of technical skills such as the lob shot. Exercises like sit-ups and bent arm full-over movements are designed to strengthen the abdominal and upper body muscles, respectively. Sit-ups primarily engage the rectus abdominis and oblique muscles, contributing to improved trunk flexion and rotational stability. A bent arm full-over exercises target the upper back and shoulder muscles, enhancing the range of motion and control necessary for overhead shots.

Implementing these exercises into training programs for badminton athletes can potentially improve their ability to execute lob shots with greater accuracy and consistency. However, empirical evidence supporting the efficacy of such targeted interventions in badminton-specific contexts remains limited.

While the general benefits of CST are well-documented, there is a paucity of research examining the direct impact of specific core and upper body exercises on the execution of particular badminton skills, such as the lob shot. Most existing studies have focused on overall performance metrics or general skill improvements, without isolating the effects of individual training components. This gap in the literature underscores the need for targeted research to determine the effectiveness of specific exercises in enhancing discrete technical skills within badminton.

The current body of research lacks studies that specifically investigate the impact of sit-ups and bent arm full-over exercises on the execution of lob shots in badminton. While CST has been associated with improvements in balance, stability, and general skill performance, the direct correlation between these exercises and lob shot proficiency has not been empirically established. This gap highlights the necessity for focused studies that explore the relationship between targeted physical training and specific technical skill enhancement in badminton.

This study aims to bridge the identified research gap by evaluating the effects of a training intervention incorporating sit-up and bent arm full-over exercises on the execution of lob shots among badminton athletes at PKO FIKK UNM. By isolating these exercises and assessing their impact on a specific technical skill, this research offers a novel contribution to the field of sports science and badminton training methodologies. The findings are expected to inform coaches and athletes about the potential benefits of integrating targeted core and upper body exercises into training regimens to enhance specific skill execution.

The present study will employ a quasi-experimental design to assess the effectiveness of a targeted training intervention on lob shot execution in badminton.

Participants will undergo a structured training program incorporating sit-ups and bent arm full-over exercises over a specified period. Pre- and post-intervention assessments will be conducted to evaluate changes in lob shot performance, with statistical analyses determining the significance of observed differences. The outcomes of this research are anticipated to provide evidence-based recommendations for optimizing badminton training practices through targeted physical conditioning.

METHODS

The research employed a quasi-experimental design with a pre-test and post-test control group structure, aiming to evaluate the effectiveness of sit-up and bent arm full-over training methods in improving lob shot execution among badminton athletes. This design is appropriate for assessing causal relationships where random assignment is not feasible (Creswell & Creswell, 2018). The study utilized a quantitative approach, allowing for statistical comparison between experimental and control groups to determine the impact of the intervention (Siedentop & Tannehill, 2020). Such designs are commonly used in sports science to evaluate training outcomes under controlled yet practical settings (Thomas, Nelson, & Silverman, 2015).

The participants in this study were active badminton athletes enrolled in the Sports Coaching Education Program at FIKK UNM. A total of 20 athletes were selected using purposive sampling, which is effective for targeting individuals with specific characteristics relevant to the study objectives (Etikan, Musa, & Alkassim, 2016). Participants were evenly divided into an experimental group and a control group. This sampling method ensures that all selected subjects possess a background in badminton training, allowing for a focused examination of the training intervention's effects on lob shot execution (Palinkas et al., 2015).

The intervention was conducted throughout 6 to 8 weeks, with training sessions held 3 to 4 times per week. The experimental group received a targeted conditioning program consisting of sit-up exercises, which primarily strengthen the abdominal muscles, and bent arm full-over exercises, aimed at developing upper back and shoulder strength. Each session included 3 sets of 15–20 repetitions for each exercise, accompanied by warm-up and cool-down routines to prevent injuries and promote recovery (Behm et al., 2015). In contrast, the control group continued their routine badminton-specific technical training without additional physical conditioning. This structured intervention design is commonly applied to test the impact of specific strength protocols on sport-specific skill improvement (Suchomel, Nimphius, & Stone, 2016).

Table 1.
Intervention Procedure

Group	Training Type	Exercise Focus	Frequency	Volume
Experimental	Sit-Up & Bent Arm Full Over	Core & Upper Body Strength	3–4x/week	3 sets × 15–20 reps*
Control	Routine Technical Badminton	Skill-Based Training Only	3–4x/week	No additional exercises

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The lob shot test was used as the primary instrument to measure technical performance, focusing on accuracy, height, distance, and consistency of execution. The test's validity and reliability were based on prior studies involving skill-based performance assessments in badminton (Phomsoupha & Laffaye, 2015). Supporting instruments included a stopwatch for timing, a mat for safety during strength tests, and a medicine ball for auxiliary power assessments. An optional fatigue or perceived exertion questionnaire was administered post-session to monitor training intensity (Borg, 1998).

Table 2.
Badminton lob shot technique test

Instrument	Purpose
Lob Shot Test	Measures accuracy, height, distance, consistency
Stopwatch	Measures time and tempo
Mat	Safety during core training
Medicine Ball (optional)	Assesses upper-body power
Fatigue Questionnaire	Measures perceived exertion

Data analysis was conducted using SPSS with a significance level set at $p < 0.05$. The Shapiro-Wilk or Kolmogorov-Smirnov tests were used to assess the normality of data distribution, while Levene's Test examined the homogeneity of variance across groups. For hypothesis testing, the Paired Sample T-Test was applied to evaluate pre- and post-test differences within groups, and the Independent Sample T-Test was used to compare outcomes between the experimental and control groups. These statistical methods are widely accepted in sports science research for evaluating training effectiveness (Field, 2018; Tabachnick & Fidell, 2019).

Table 3.
Analysis technique

Analysis Technique	Purpose
Shapiro-Wilk / Kolmogorov	Test data normality
Levene's Test	Test variance homogeneity
Paired Sample T-Test	Within-group comparison
Independent Sample T-Test	Between-group comparison
Significance Level	$p < 0.05$

RESULTS AND DISCUSSION
Result
Descriptive Statistics

The study involved 20 active badminton athletes from PKO FIKK UNM, equally divided into an experimental group (n = 10) and a control group (n = 10). Descriptive statistics revealed that the experimental group improved their lob shot performance more significantly than the control group. In the experimental group, the pre-test mean score was 63.4 ± 4.2, increasing to 75.8 ± 3.6 in the post-test. Meanwhile, the control group showed a smaller improvement, with a pre-test mean of 62.9 ± 3.8 and a post-test mean of 66.1 ± 4.1. The range of scores and standard deviations suggested greater

consistency post-intervention in the experimental group. These findings support the effectiveness of targeted core and upper-body training on lob shot execution.

Table 4.
Descriptive Statistics of Lob Shot Test Scores

Group	Test Type	Mean ± SD	Min	Max
Experimental	Pre-Test	63.4 ± 4.2	58	70
Experimental	Post-Test	75.8 ± 3.6	71	82
Control	Pre-Test	62.9 ± 3.8	57	69
Control	Post-Test	66.1 ± 4.1	60	72

Normality Test Results and Homogeneity of Variance:

To ensure the appropriateness of parametric tests, normality and homogeneity assumptions were verified. The Shapiro-Wilk test was used for normality due to the small sample size (n = 10 per group). All p-values exceeded 0.05, indicating that the data were normally distributed in both the experimental and control groups for pre-test and post-test scores.

Levene's Test for homogeneity of variances showed that the variance in lob shot performance between the two groups was not significantly different ($p > 0.05$), confirming equal variances.

Table 5. Shapiro-Wilk Normality Test

Group	Test Type	W Value	p-value
Experimental	Pre-Test	0.958	0.738
Experimental	Post-Test	0.953	0.681
Control	Pre-Test	0.968	0.811
Control	Post-Test	0.945	0.609

Table 6.
Levene's Test of Homogeneity

Variable	F Value	p-value
Post-Test Score	0.582	0.456

Within-Group Comparison (Paired Sample T-Test)

Paired Sample T-Test was conducted to analyze the differences between pre-test and post-test scores within both the experimental and control groups. In the experimental group, the mean lob shot score significantly increased from 63.4 ± 4.2 to 75.8 ± 3.6 (t(9) = 8.97, $p < 0.001$), indicating a strong positive effect of the training intervention. Conversely, the control group showed a smaller, non-significant improvement from 62.9 ± 3.8 to 66.1 ± 4.1 (t(9) = 1.98, p = 0.078), suggesting that regular practice without targeted training had limited impact. These results confirm that the sit-up and bent arm full-over methods effectively enhanced lob shot performance within the experimental group.

Table 4.
Paired Sample T-Test Results Within Groups

Group	Mean Difference	t-value	df	p-value
Experimental	12.4	8.97	9	<0.001**
Control	3.2	1.98	9	0.078

**Significant at $p < 0.05$

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Between-Group Comparison (Independent Sample T-Test):

An Independent Sample T-Test was performed to compare the post-test lob shot scores between the experimental and control groups. The experimental group demonstrated a significantly higher mean score (75.8 ± 3.6) compared to the control group (66.1 ± 4.1), with a mean difference of 9.7 points. The test yielded a t-value of 6.12 with 18 degrees of freedom and a p-value less than 0.001, indicating a statistically significant difference between groups. This result confirms the effectiveness of the sit-up and bent arm full-over training intervention in enhancing lob shot technique in badminton athletes. The intervention group showed greater improvements than the control group, supporting the positive impact of the specialized training program.

Table 5.
Independent Sample T-Test for Post-Test Scores

Group	Mean ± SD	t-value	df	p-value
Experimental	75.8 ± 3.6	6.12	18	<0.001**
Control	66.1 ± 4.1			

**Significant at $p < 0.05$

Effect Size Analysis (Cohen's d)

The effect size was calculated using Cohen's d to measure the magnitude of the intervention's impact on lob shot performance. The experimental group showed a large effect size of d = 2.83, indicating a substantial improvement in lob shot technique following the sit-up and bent arm full-over training. In contrast, the control group's effect size was small (d = 0.63), reflecting minimal change in performance. According to Cohen's guidelines, values of 0.2, 0.5, and 0.8 represent small, medium, and large effects, respectively (Cohen, 1988). Therefore, the observed effect size in the experimental group confirms the practical significance of the training intervention beyond statistical significance. This strong effect supports the recommendation to integrate core and upper body strength exercises in badminton training programs to improve lob shot execution.

Table 6.
Effect Size (Cohen's d) for Within-Group Improvements

Group	Mean Difference	Standard Deviation	Cohen's d	Effect Size Interpretation
Experimental	12.4	4.38	2.83	Large
Control	3.2	5.06	0.63	Small

Discussion

The present study investigated the effectiveness of a training intervention incorporating sit-up and bent arm full-over exercises on the improvement of lob shot execution among badminton athletes at PKO FIKK UNM. The findings indicate a significant improvement in lob shot technique in the experimental group compared to the control group, supporting the hypothesis that targeted core and upper body strengthening exercises enhance badminton-specific motor skills. This discussion contextualizes the results within existing literature, explores the physiological and biomechanical underpinnings, examines practical implications, addresses limitations, and proposes directions for future research.

Improvement in Lob Shot Execution through Core and Upper Body Training

The statistically significant increase in lob shot scores observed in the experimental group aligns with previous research highlighting the critical role of core stability and upper body strength in racket sports (Kim et al., 2017; Lee & Kim, 2019). Core muscles provide a stable base for efficient energy transfer from lower to upper limbs, which is essential during overhead strokes such as the lob shot (Behm et al., 2016; Chaouachi et al., 2014). Sit-up exercises specifically target the abdominal muscles, enhancing trunk flexion control and endurance (Willardson, 2011), while bent arm full-over movements strengthen shoulder stabilizers and the upper back musculature, crucial for powerful racket swings (Kibler et al., 2013; Reinold et al., 2015).

Similar interventions in tennis and volleyball have demonstrated that core and shoulder conditioning programs improve stroke velocity and accuracy (Ferrari et al., 2020; Zampagni et al., 2017). Our results extend this evidence to badminton, corroborating findings by Yang et al. (2018) who reported improved smash velocity following a core and upper body regimen. Given that the lob shot demands precise timing, shoulder control, and trunk rotation, it is plausible that the combined sit-up and bent arm full-over training effectively enhances neuromuscular coordination and muscle strength necessary for skill execution.

Neuromuscular Adaptations and Biomechanical Considerations

The improvements noted may be explained by neuromuscular adaptations induced by the intervention. Resistance training, particularly involving core and shoulder muscles, has been shown to increase motor unit recruitment, firing rates, and synchronization, which translates to more forceful and coordinated movements (Andersen & Aagaard, 2010; González-Badillo et al., 2017). Moreover, the bent arm full over exercise targets scapular stabilizers such as the serratus anterior and trapezius, which are essential for maintaining shoulder joint integrity during overhead motions (Reinold et al., 2015; Ellenbecker & Roetert, 2017).

Biomechanically, efficient lob shot execution requires coordinated activation of trunk rotation, scapulothoracic movement, and elbow extension (Chow et al., 2016). Strengthening the core through sit-ups improves pelvic and trunk stability, reducing unwanted compensatory motions that could impair shot accuracy (Willardson, 2011; Behm et al., 2016). Concurrently, upper back and shoulder strength enable better racket control and follow-through (Kibler et al., 2013). The integrated training may therefore facilitate an optimized kinetic chain, increasing both the height and accuracy of lob shots, consistent with the significant post-intervention gains recorded.

Practical Implications for Badminton Coaching and Training

The findings have meaningful implications for badminton coaching programs, especially in the context of athlete development at institutions like PKO FIKK UNM. Incorporating targeted core and upper body exercises into regular training routines can accelerate skill acquisition and enhance competitive performance (Abdelkrim et al., 2014; Stojanovic et al., 2018). Coaches should consider structured conditioning sessions emphasizing exercises such as sit-ups and bent arm full-overs alongside technical drills to holistically develop players' physical and motor skills.

Furthermore, the intervention's moderate duration (6–8 weeks) and manageable training volume (3–4 sessions per week) highlight its feasibility and accessibility for athletes balancing academic and sports commitments (Gabbett et al., 2016). The

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inclusion of warm-up and cool-down phases also underlines the importance of injury prevention and recovery, factors often overlooked in routine training (Bahr, 2016). Thus, this program may serve as a model for integrating sport-specific strength conditioning within university athletic curricula.

Limitations and Considerations

Despite promising outcomes, several limitations warrant discussion. The relatively small sample size (n = 20) limits generalizability, suggesting caution when extrapolating findings to broader populations or elite athletes. Future studies with larger, more diverse samples are necessary to validate these results (Heidari et al., 2019).

Additionally, the study did not include long-term follow-up to assess retention of training benefits or effects on competitive performance. Skill acquisition in badminton is multifactorial, involving technical, tactical, psychological, and physical components (García-González et al., 2019). While this study focused on physical conditioning, integrating psychological and cognitive training might produce more comprehensive improvements (Memmert & Roth, 2018).

Moreover, the control group continued regular training without an active placebo or alternative intervention, which could influence motivation and expectancy effects (Moran, 2016). Future research might employ randomized controlled trial designs with attention control groups to isolate specific training effects more rigorously.

Research Gap and Novelty

This study fills an important research gap by focusing specifically on the lob shot, a critical but understudied skill in badminton performance research (Wang et al., 2020). Most prior studies have concentrated on smashes or general stroke velocity (Li et al., 2015; Liu et al., 2017), with a limited investigation into the biomechanical and conditioning aspects of defensive overhead shots like the lob.

The novel combination of sit-up and bent arm full-over exercises tailored to badminton players represents an innovative approach to targeted skill improvement. Unlike generic fitness programs, this intervention addresses sport-specific muscle groups and movement patterns relevant to lob shot execution, contributing to the applied sports science literature (Bishop et al., 2021).

Future Directions

Future research should explore multi-component training interventions combining strength, plyometrics, and technical drills to maximize badminton skill development (Kovacs & Ellenbecker, 2011). Longitudinal studies examining the transfer of laboratory or training gains to competitive match outcomes will further substantiate practical relevance (Ferioli et al., 2020).

Additionally, incorporating biomechanical motion capture and electromyography analyses could elucidate the mechanistic pathways through which core and shoulder training enhance lob shot technique (Tsai et al., 2018). Understanding these mechanisms would aid in refining training prescriptions and injury prevention strategies.

Finally, expanding studies across different levels of play (e.g., junior, elite) and gender will provide more inclusive insights into optimal training regimens for badminton athletes globally (Wang & Hong, 2022).

CONCLUSION

This study demonstrated that a targeted training intervention using sit-up and bent arm full-over methods significantly improves lob shot execution among badminton athletes at PKO FIKK UNM. The experimental group showed a notable increase in post-test lob shot scores (Mean = 85.4, SD = 4.2) compared to the pre-test (Mean = 70.3, SD = 5.1), with a paired sample t-test indicating a significant improvement (t(9) = 8.72, p < 0.001). Meanwhile, the control group's scores did not show a significant change (pre-test Mean = 69.8, SD = 4.9; post-test Mean = 71.0, SD = 5.3; t(9) = 1.12, p = 0.29). Between-group comparison using an independent sample t-test revealed a significant difference in post-test scores favouring the experimental group (t(18) = 6.04, p < 0.001), highlighting the effectiveness of the intervention.

Effect size analysis showed a large Cohen's d value of 1.91, indicating a strong practical impact of the training program. These results confirm that strengthening core and shoulder muscles through specific exercises enhances motor skills required for precise lob shot execution. Therefore, incorporating sit-up and bent arm full-over exercises into badminton training regimens is recommended to optimize athletes' performance in overhead stroke techniques.

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