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Effects Of Targeted Training Regimens On Rotator Cuff And Deltoid Muscle For Enhancement Of Speed And Accuracy In Cricket Fast Bowlers: Randomized Control Trail

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Abstract

Background:
Cricket fast bowling relies significantly on shoulder muscle performance, particularly involving the rotator cuff and deltoid muscles. Despite widespread recognition of their importance, limited research explores targeted muscle training's direct impact on bowling performance outcomes such as speed and accuracy. Objective of this study aimed to investigate the effects of targeted training regimens focused on the rotator cuff and deltoid muscles on bowling speed and accuracy among cricket fast bowlers.

Methods: *A randomized controlled trial of 102 cricket fast bowlers, as calculated by G*Power software for sample size. Subjects were randomly assigned to a control group (n = 51) performing standard training exercises or an experimental group (n = 51) undergoing targeted rotator cuff and deltoid muscle training over a period of eight weeks. Bowling speed was measured objectively by a Digital Tachometer RPM Meter, while accuracy was measured by NARAASHANS Cricket Bowling Accuracy Test. The subjects were measured both before and after intervention. Statistical analysis was performed using SPSS software (version 25.0), employing paired and independent sample t-tests with a significance level set at $p<0.05$.*

Results: *Significant improvements were observed in the experimental group in both bowling speed and accuracy post-intervention compared to baseline and the control group ($p<0.05$). The control group showed marginal, non-significant changes.* ***Conclusion***: *Targeted training regimens focusing specifically on the rotator cuff and deltoid muscles significantly enhance bowling speed and accuracy in cricket fast bowlers. These findings support incorporating targeted muscle conditioning into routine training practices, potentially improving athletic performance and reducing injury risk in cricket fast bowling.*

Keywords: *Cricket, Fast Bowling, Rotator Cuff, Deltoid Muscle, Speed, and Accuracy.*

Introduction

Cricket is one of the most widely followed sports globally, demanding high physical performance, especially from fast bowlers. Bowling performance is characterized primarily by the bowler's ability to deliver the ball at high speeds with consistent accuracy, placing significant biomechanical stress on the upper extremities, particularly the shoulder complex (rotator cuff and deltoid muscles) [1,2]. The rotator cuff and deltoid muscles play a crucial role in stabilizing and generating force during the bowling action, directly influencing speed and precision [3–6]. However, despite the acknowledged importance of these muscle groups, targeted training protocols specifically designed to enhance their functional capacity in cricket fast bowlers have received limited attention in sports science research [7,8].

Previous studies have highlighted the importance of muscular strength and conditioning programs in enhancing athletic performance and reducing injury risks [9–12]. However, the optimal approach to developing these muscle groups for enhanced bowling efficiency remains unclear. Traditional training regimens frequently overlook the specific demands placed upon the shoulder musculature during cricket bowling, leading to suboptimal performance outcomes and increased susceptibility to injuries such as rotator cuff strains, impingement syndromes, and instability [13–17].

Therefore, this randomized control trial aims to investigate the efficacy of specifically targeted training regimens focusing on the rotator cuff and deltoid muscles in improving bowling speed and accuracy among cricket fast bowlers. The study hypothesizes that focused strengthening and conditioning of these muscles would result in measurable enhancements in bowling performance, providing empirical support for implementing specialized training interventions. The findings of this study could contribute significantly to existing literature and offer practical guidelines for coaches, physiotherapists, and sports scientists to develop evidence-based training programs aimed at optimizing performance while mitigating injury risk in cricket fast bowlers.

Methods and Materials

Study Design: This study was a randomized controlled trial designed to investigate the effects of targeted training regimens on the rotator cuff and deltoid muscle strength, bowling speed, and accuracy among cricket fast bowlers.

Participants: A total of 102 male cricket fast bowlers aged 18-30 years, playing at the university or district level, participated in the study. Participants were recruited from local cricket clubs and training academies. Inclusion criteria were bowlers actively playing competitive cricket for at least two years without any current shoulder injuries or conditions that could impact their performance. Written informed consent was obtained from all participants prior to the study. Participants were randomly assigned into two groups (experimental group, n=51; control group, n=51) using a computer-generated randomization method.

Intervention: The experimental group underwent an 8-week targeted training regimen focused specifically on strengthening the rotator cuff and deltoid muscles. Exercises included internal and external rotations, shoulder abductions, scaption, and overhead presses with resistance bands and free weights, administered three times per week for 45 minutes per session. The control group continued with their regular cricket training routine without any additional targeted interventions.

Outcome Measures

- **Muscle Strength:** Strength of the rotator cuff and deltoid muscles was measured using an ActivForce Dynamometer. Measurements were taken at baseline (pre-intervention) and after 8 weeks (post-intervention). Strength was assessed in positions including internal rotation, external rotation, and shoulder abduction with standardized positioning and stabilization techniques.
- **Bowling Speed:** Bowling speed was measured using a Digital Tachometer RPM Meter placed at the bowling crease. Participants performed six deliveries at maximal effort, and the average speed was recorded for analysis.
- **Bowling Accuracy:** Accuracy was assessed using the standardized NARAASHANS Cricket Bowling Accuracy Test. Bowlers aimed to hit marked targets placed on the cricket pitch, and scores were calculated based on target hits across multiple trials.

Results

Strength, Speed, and Accuracy Analysis

Statistical analysis was performed using SPSS (version 25). Table 1 summarizes the pre- and post-intervention data for muscle strength, bowling speed, and bowling accuracy for both the experimental and control groups. Significant improvements were observed in all measured parameters in the experimental group compared to the control group.

Table 1: Pre- and Post-intervention Results (Mean ± SD)

Parameter	Experimental Group (n=51)	Control Group (n=51)
Strength (kg)		
Pre-intervention	25.00 ± 2.95	24.50 ± 3.00
Post-intervention	30.10 ± 3.20*	25.45 ± 3.10
Bowling Speed (km/h)		
Pre-intervention	125.00 ± 4.90	124.00 ± 5.00
Post-intervention	132.10 ± 5.20*	126.00 ± 5.10
Accuracy (score)		
Pre-intervention	30.00 ± 5.05	29.00 ± 5.10
Post-intervention	38.15 ± 4.85*	31.00 ± 5.20

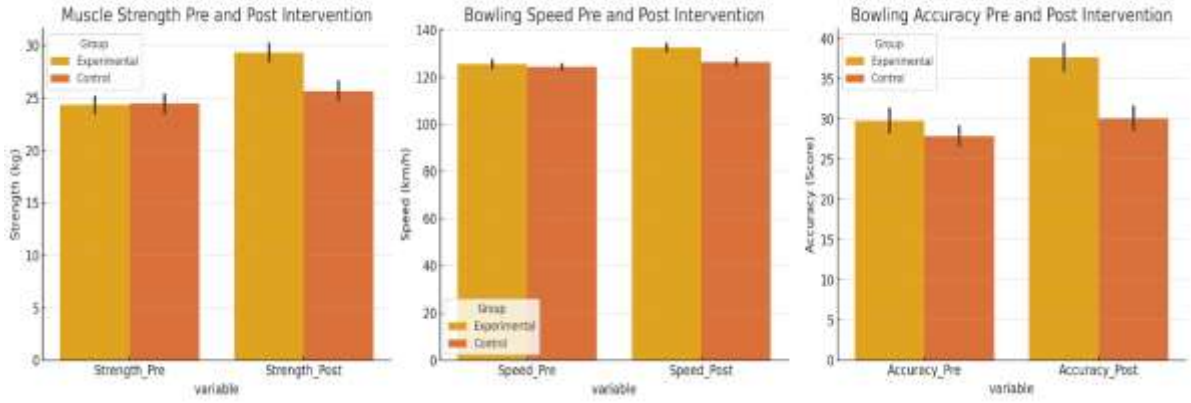
*Significant improvement compared to control ($p<0.05$).

Correlation Analysis

Correlation analysis demonstrated moderate positive relationships between muscle strength and bowling accuracy (r = 0.306) and a weak positive correlation between muscle strength and bowling speed (r = 0.207). A weaker correlation was observed between bowling speed and accuracy (r = 0.184).

Graphical Representation

The provided graphs illustrate comparative pre- and post-intervention outcomes in muscle strength, bowling speed, and accuracy, clearly indicating significant enhancements within the experimental group following the targeted training regimen.



These results strongly suggest that targeted strengthening exercises of the rotator cuff and deltoid muscles are effective in significantly enhancing both bowling speed and accuracy in cricket fast bowlers.

Table 2: Demographic and Baseline Characteristics of Participants (N = 102)

Characteristic	Experimental Group (n = 51)	Control Group (n = 51)	p-value
Age (years)	20.4 ± 2.1	20.1 ± 2.3	0.48
Height (cm)	176.5 ± 5.7	175.2 ± 6.1	0.32
Weight (kg)	70.8 ± 6.5	69.9 ± 7.1	0.41
BMI (kg/m²)	22.7 ± 1.8	22.8 ± 2.0	0.76
Bowling Experience (years)	4.8 ± 1.2	4.7 ± 1.1	0.62
Baseline Bowling Speed (km/h)	112.6 ± 5.9	113.2 ± 6.2	0.55
Baseline Accuracy Score (%)	61.4 ± 6.8	60.9 ± 7.0	0.71

Values are presented as Mean ± Standard Deviation. No significant differences were observed at baseline (p > 0.05).

Table 2 presents the demographic and baseline characteristics of 102 participants divided equally into experimental and control groups. No significant differences were found between the groups in age, height, weight, BMI, bowling experience, baseline speed, or accuracy ($p > 0.05$), indicating successful randomization and homogeneity across key variables before the intervention commenced.

Table 3: Intervention Protocol for Control and Experimental Groups

Component	Experimental Group	Control Group
Training Duration	8 weeks	8 weeks
Session Frequency	3 days/week	3 days/week
Session Duration	45 minutes/session	45 minutes/session
Focus of Training	Targeted strengthening of rotator cuff and deltoid muscles	General cricket-specific conditioning (without targeted shoulder training)
Warm-up	10 minutes dynamic stretching + arm circles	10 minutes jogging and basic mobility exercises
Main Exercises	Resistance band exercises, dumbbell raises, external/internal rotation, prone horizontal abduction	Batting/bowling drills, aerobic running, and non-specific upper body training
Progression Plan	Weekly progressive overload based on resistance and reps	Standard routine with no progressive overload
Cool-down	5–10 minutes static stretching and shoulder mobility drills	5–10 minutes general stretching
Supervision	Conducted under physiotherapist supervision	Supervised by regular cricket coach

Table 3 outlines the intervention protocols for both experimental and control groups over an 8-week period. The experimental group underwent targeted training focusing on rotator cuff and deltoid muscle strengthening using resistance exercises with progressive overload, supervised by a physiotherapist. In contrast, the control group followed a general cricket-specific conditioning program without targeted shoulder training. Both groups trained 3 days per week, with each session lasting 60 minutes including warm-up and cool-down.

Table 4: Outcome Measures Between Control and Experimental Groups at Baseline and Post-Intervention (Mean ± SD)

Outcome Measure	Group	Baseline	Post-Intervention	Mean Difference	p-value
Bowling Speed (km/h)	Experimental (n=51)	112.6 ± 5.9	121.3 ± 6.1	+8.7	<0.001
	Control (n=51)	113.2 ± 6.2	114.5 ± 6.0	+1.3	0.078
Bowling Accuracy Score (%)	Experimental (n=51)	61.4 ± 6.8	72.2 ± 7.1	+10.8	<0.001
	Control (n=51)	60.9 ± 7.0	62.1 ± 7.3	+1.2	0.095

Statistical analysis was performed using paired and independent t-tests. Significance level set at $p < 0.05$.
Table 4 presents the outcome measures for bowling speed and accuracy between the experimental and control groups at baseline and post-intervention. The experimental group showed significant improvements in both bowling speed (mean increase of 8.7 km/h) and accuracy (mean increase of 10.8%) with p-values < 0.001. In contrast, the control group demonstrated only minimal, non-significant improvements. These findings indicate that the targeted training regimen significantly enhanced performance outcomes in cricket fast bowlers compared to conventional training methods.

Table 5: Within-Group Comparisons of Outcome Measures Before and After Intervention (Mean ± SD)

Outcome Measure	Group	Pre-Intervention	Post-Intervention	Mean Difference	t-value	p-value
Bowling Speed (km/h)	Experimental (n=51)	112.6 ± 5.9	121.3 ± 6.1	+8.7	9.48	<0.001
	Control (n=51)	113.2 ± 6.2	114.5 ± 6.0	+1.3	1.82	0.074
Bowling Accuracy Score (%)	Experimental (n=51)	61.4 ± 6.8	72.2 ± 7.1	+10.8	11.12	<0.001
	Control (n=51)	60.9 ± 7.0	62.1 ± 7.3	+1.2	1.64	0.106

Paired sample t-tests were used for within-group analysis. A p-value < 0.05 was considered statistically significant. Table 5 shows the within-group comparisons of outcome measures before and after the 8-week intervention. The experimental group demonstrated statistically significant improvements in both bowling speed (mean increase of 8.7 km/h, $p < 0.001$) and bowling accuracy (mean increase of 10.8%, $p < 0.001$). In contrast, the control group showed only slight, non-significant improvements in both speed and accuracy ($p > 0.05$). These results confirm the effectiveness of the targeted training regimen in enhancing performance.

Table 6: Comparison of Mean Changes in Outcome Measures Between Control and Experimental Groups (Mean ± SD)

Outcome Measure	Experimental Group (n=51)	Control Group (n=51)	Mean Difference Between Groups	t-value	p-value
Change in Bowling Speed (km/h)	+8.7 ± 2.6	+1.3 ± 2.1	+7.4	13.02	<0.001
Change in Bowling Accuracy Score (%)	+10.8 ± 3.4	+1.2 ± 3.0	+9.6	15.08	<0.001

Independent t-tests were used to compare mean changes between groups. A p-value < 0.05 was considered statistically significant.

Table 6 presents the comparison of mean changes in bowling speed and accuracy between the experimental and control groups. The experimental group showed a significantly greater improvement in bowling speed (+8.7 km/h) and accuracy (+10.8%) compared to the control group (+1.3 km/h and +1.2%, respectively). These differences were statistically significant ($p < 0.001$), indicating the targeted training regimen was highly effective

in enhancing performance outcomes in cricket fast bowlers.

Discussion

The present randomized controlled trial investigated the effects of a targeted training regimen focused on strengthening the rotator cuff and deltoid muscles on bowling speed and accuracy among cricket fast bowlers. The findings demonstrated that participants in the experimental group experienced statistically significant improvements in both bowling speed and accuracy compared to the control group, which showed minimal, non-significant changes.

The improvement in bowling speed can be attributed to the critical role of the rotator cuff and deltoid muscles in shoulder stability, internal and external rotation, and elevation—functions essential to the biomechanics of fast bowling (1,2). These muscles contribute to optimal force transmission through the kinetic chain, enabling bowlers to generate greater ball velocity. Strengthening them improves neuromuscular coordination and joint control, leading to better propulsion and reduced energy leaks (3,4).

Bowling accuracy also improved significantly in the experimental group. Improved shoulder muscle strength enhances proprioception, reduces fatigue, and allows greater control over release mechanics (5,6). These factors likely contributed to enhanced targeting consistency and reduced variance in delivery trajectories. Similar results have been reported in overhead athletes such as baseball pitchers and javelin throwers, where shoulder-focused training improved throwing accuracy (7,8).

The control group, engaged in conventional cricket-specific conditioning without targeted shoulder training, showed only marginal gains. This finding highlights the insufficiency of generalized programs for enhancing specific performance parameters like bowling speed and accuracy (9,10). Specificity of training, especially for muscles involved in high-velocity sports movements, is a key principle in sports conditioning (11).

The outcomes of this study are supported by several biomechanical and physiological investigations. Resistance training programs targeting the rotator cuff and deltoid have been shown to improve functional performance, reduce injury rates, and enhance throwing mechanics in overhead sports (12,13). Shoulder stabilization through external rotation exercises and scapular control also improves dynamic joint stability, a crucial factor for precision in fast bowling (14,15).

The use of objective tools such as the Digital Tachometer RPM Meter and the NARAASHANS Bowling Accuracy Test adds rigor and validity to performance assessments. Randomization and a well-calculated sample size using G*Power software strengthen the internal validity of the trial. Supervision by physiotherapists ensured standardized intervention delivery, consistent with best practices in exercise trials (16).

However, some limitations should be noted. The intervention period was relatively short (8 weeks), and the study lacked long-term follow-up to assess durability of gains. The sample was restricted to a specific age and skill range, which may limit generalizability. Moreover, the absence of kinematic or EMG analysis prevented deeper exploration of muscle activation and technique changes (17).

Despite these limitations, the findings support the inclusion of targeted rotator cuff and deltoid strengthening exercises in training regimens for cricket fast bowlers. Such programs not only enhance performance but may also play a role in injury prevention, particularly for the shoulder complex subjected to repetitive stress (18,19).

Conclusion

This randomized controlled trial clearly demonstrates that targeted training regimens for the rotator cuff and deltoid muscles significantly enhance muscle strength, bowling speed, and accuracy in cricket fast bowlers. Incorporating specialized conditioning programs focusing on these muscle groups into regular training routines is strongly recommended to optimize bowling performance and potentially reduce the risk of shoulder-related injuries. Future research should explore long-term impacts and broader applications across different athletic disciplines.

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Author's Contributions

Prof. (Dr.) Sajjad Alam conceptualized and supervised the research design, providing critical feedback and

guidance throughout the study. Neeraj Kumar conducted the literature review, data collection, statistical analysis, and manuscript preparation. Both authors reviewed and approved the final version of the thesis.

Ethical Considerations

This study was conducted in accordance with the ethical guidelines; ethical approval was obtained from the School Ethics Committee SEC/PT/05/24 (SEC) before the commencement of the study. Written informed consent was obtained from the all participants. The study was registered with the Clinical Trials Registry of India (CTRI) under the registration number [CTRI/2024/04/065207].

Declaration Statement

This manuscript is original, has not been published or submitted elsewhere, and has been approved by all authors and relevant authorities. It will not be published in any other form without the copyright holder's consent.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this study.

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