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Effects of Upper Limb Progressive Resistance Training Along with Core Stability Exercises on Pain, Core Muscular Endurance and Upper Limb Balance in Cricket Fast Bowlers with Shoulder Disorder: A Randomized Controlled Trial

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A B S T R A C T

Background: Cricket fast bowlers are generous and particularly susceptible to shoulder problems due to the repetitive overhead movements they perform, and the substantial biomechanical stress associated with fast bowling. Shoulder disorders among them are normally associated with shoulder pain, poor core muscular endurance and some dysfunction in upper limb dynamic balance. Thus, it may be reasonable to expect that the integration of upper limb progressive resistance training and core stability training would be somewhat more comprehensive as a rehabilitation program and enhance functional performance.

Objective: To investigate the effect of the upper limb progressive resistance training with core stability on shoulder pain, core endurance, and upper limb dynamic balance in fast bowlers with shoulder disorders.

Methodology: Four-month randomized controlled trial (April-July 2025) at cricket clubs of Hyderabad and Jamshoro, Pakistan. Forty-eight male fast bowlers aged 18-35 years with shoulder disorders were divided randomly into two groups through the lottery method. Group A was exposed to a six-week intervention consisting of upper limb progressive resistance training with core stability exercises, whereas Group B only had progressive resistance training alone. The outcomes were measured both at baseline and post-intervention using the Visual Analog Scale (VAS), the Upper Quarter Y-Balance Test (UQYBT), and the plank endurance test. The statistics were performed using the Statistical Package for the Social Sciences (SPSS) version 23, and the level of significance was determined to be $p<0.05$. (ClinicalTrials.gov Registry No. NCT07055685)

Results: Significant improvements in pain, upper limb dynamic balance, and core muscular endurance were observed in both groups immediately after the intervention ($p<0.05$). Nevertheless, the combination of interventions group demonstrated significant decreases in pain, as well as increased upper limb dynamic balance and core muscular endurance, when compared to progressive resistance training group. In relation to the between group outcomes, there was a significant difference in all major outcome measures favoring the combined intervention group.

Conclusion: The study concluded that performing upper limb progressive resistance training in combination with core stability exercises is more beneficial than conducting only progressive resistance training regarding pain reduction and upper limb dynamic balance and core muscular endurance in fast bowlers with shoulder disorders.

Keywords: Core endurance, Fast-bowler, Resistance Training, Shoulder Disorders

Introduction

Cricket fast bowlers endure high physical demands, repeatedly performing powerful overhead actions that strain the shoulder complex. This repetitive motion and rapid rotation often lead to overuse injuries, making shoulder issues prevalent in this group.[1] Optimal fast bowling biomechanics involve efficient energy transfer through a kinetic chain from the lower limbs to a stable core and shoulder. Poor mechanics, such as excessive trunk flexion or premature shoulder internal rotation, disrupt this sequence and place abnormal stress on the rotator cuff. These aberrant patterns predispose the shoulder to impingement and degenerative injury.[2] Common injuries include rotator cuff tendinopathy, labral tears, impingement, and scapular dyskinesis—often resulting from muscle imbalances, fatigue, and inadequate stability.[3] Risk factors include high bowling volumes, poor rest, weak core muscular endurance, and faulty technique. Shoulder injuries account for 11–16% of all fast bowler injuries, significantly impacting performance and career longevity.[4]

Evaluation of shoulder injuries in fast bowlers is grounded in understanding the biomechanical demands of the bowling action.[5] The repetitive, high-velocity overhead motion requires optimal force transfer through the kinetic chain; thus, assessment must prioritize the identification of mechanical flaws that contribute to injury.[6] Clinical examination, including inspection, palpation, and range of motion testing, is interpreted within this biomechanical context.[7] Strength assessment of the rotator cuff and scapular stabilizers is performed alongside special tests for impingement or instability.[8] Functional evaluations, such as the Upper Quarter Y-Balance Test and core endurance screens, are essential for detecting compensatory patterns and kinetic chain deficits that predispose bowlers to shoulder pathology.[9]

Conservative management remains the primary approach for shoulder injuries in fast bowlers, focusing on pain relief, mobility restoration, and functional recovery.[10] Initial interventions include rest, cryotherapy, NSAIDs, and manual therapy techniques such as joint mobilization and soft tissue release.[11] As symptoms subside, rehabilitation progresses to targeted strengthening of the rotator cuff, deltoid, and scapular stabilizers using resistance-based exercises.[12] An effective program incorporates flexibility, proprioceptive neuromuscular facilitation (PNF), and kinetic chain training to enhance whole-body mechanics.[13] Integrating progressive resistance training (PRT) with core stability exercises has shown to be particularly effective, improving neuromuscular control and reducing compensatory shoulder loading.[14] Core exercises such as planks, bird-dogs, and anti-rotation drills support trunk stability, which is essential for optimal shoulder function during high-demand activities like bowling. This combined approach promotes pain reduction, biomechanical efficiency, and injury prevention.[15]

Research supports the combined use of progressive resistance training and core stability exercises for improving postural alignment, muscular balance, and athletic performance. Despite the high incidence of shoulder injuries among cricket fast bowlers, limited evidence exists on integrated rehabilitation protocols that concurrently address both upper limb and core stability. Current rehabilitation approaches often target the shoulder in isolation, neglecting the proximal contributions of the lumbopelvic complex to injury mechanisms. This study aims to fill that gap by evaluating the combined effects of a structured program integrating progressive upper limb resistance training with targeted core stability exercises.

Specifically, this study will investigate how this combined intervention influences key clinical outcomes: pain reduction, core muscular endurance, and upper limb dynamic balance. Core endurance will be quantified through validated tests such as the prone plank and sidebridge, while upper limb balance and stability will be assessed using the Upper Quarter Y-Balance Test (UQYBT). By establishing a dose-response relationship between the intervention and these outcomes, this research seeks to provide an evidence-based framework to guide rehabilitation. The ultimate goal is to enhance functional recovery and mitigate reinjury risk by restoring kinetic chain integrity in this athletic population.

Methodology

A randomized clinical trial conducted at cricket clubs in Hyderabad and Jamshoro districts, Sindh, Pakistan, over a period of four months (from April 2025 to June 2025), following ethical approval (IRB/FAHS/REHAB/02/25/MS/RS-3651). The sample size was calculated using G*Power 3.1 software based on the primary outcome of pain intensity measured by the Visual Analogue Scale (VAS). Using an effect size of 0.65, and α error probability of 0.05, and a power ($1-\beta$) of 0.80, the calculation yielded a total of 48 participants. To account for potential attrition, 52 participants were recruited using a convenient sampling technique. District-level male fast bowlers aged 18–35 years with shoulder pain lasting 4 weeks to 6 months were recruited. Exclusion criteria included shoulder surgery or dislocation within the past year, neurological/systemic disorders, current involvement in other rehabilitation programs, or upper limb deformities.

A single-blind, randomized controlled design was employed. Participants were allocated to intervention groups using a computer-generated random sequence with allocation concealment via sequentially numbered, opaque, sealed envelopes to ensure blinding of group assignment. Assessments were performed at two time points: pre-intervention (Week 0) and post-intervention (Week 6) by an assessor blinded to group allocation, using validated and reliable tools. Pain intensity was measured using the Visual Analog Scale (VAS; ICC = 0.80-0.94), a 0–10 cm subjective pain perception scale. Upper limb dynamic balance and motor control were assessed using the Upper Quarter Y-Balance Test (UQYBT), which required participants to perform unilateral reaching tasks in three directions from a push-up position. Core stability was evaluated using the plank endurance test, which recorded the duration a participant could maintain a neutral spine while supported on forearms and toes. These tools collectively provided a comprehensive assessment of functional recovery in cricket fast bowlers undergoing rehabilitation.

Group A engaged in a combined program of progressive resistance training (PRT) and core stability exercises aimed at improving both upper limb strength and trunk stabilization. The core stability exercises focused on enhancing neuromuscular control and trunk endurance, essential for maintaining proper posture and reducing compensatory movements during high-force actions. The core exercises included planks (30–60 seconds), bird-dog (5–10 seconds per repetition, 10–12 reps per side), dead bug (3–5 seconds per repetition, 12–15 reps), bridging (10–15 seconds per repetition, 12–15 reps), and Swiss ball stability (20–30 seconds per position, 10–12 reps).

The PRT program for Group A focused on strengthening the shoulder complex, upper back, and arm muscles, using exercises such as overhead press, bent-over rows, external rotations with bands, biceps curls, triceps extensions, and push-ups. In the first two weeks, intensity was set at 50–60% of one-repetition maximum (1RM), with participants performing 12–15 reps for 2–3 sets. From weeks 3 to 4, intensity increased to 60–65% 1RM with 10–12 reps for 3–4 sets, and from weeks 5 to 6 intensity reached 70–80% 1RM with 8–10 reps for 3–4 sets.

Group B performed the same progressive resistance training regimen as Group A, focusing solely on the upper limb balance and coordination component. The exercises were the same as those in Group A, progressing similarly in intensity from weeks 3 to 4, intensity increased to 60–65% 1RM with 10–12 reps for 3–4 sets, and from weeks 5 to 6 intensity reached 70–80% 1RM with 8–10 reps for 3–4 sets. Both groups underwent their respective interventions three times a week, with each session lasting approximately 30–40 minutes. The collected data were analysed via the Statistical Package for the Social Sciences (SPSS) version 23, and the statistical significance level was set at $p<0.05$. Normally distributed data were assessed via the Shapiro–Wilk test, and parametric tests were applied for within and between groups analysis.

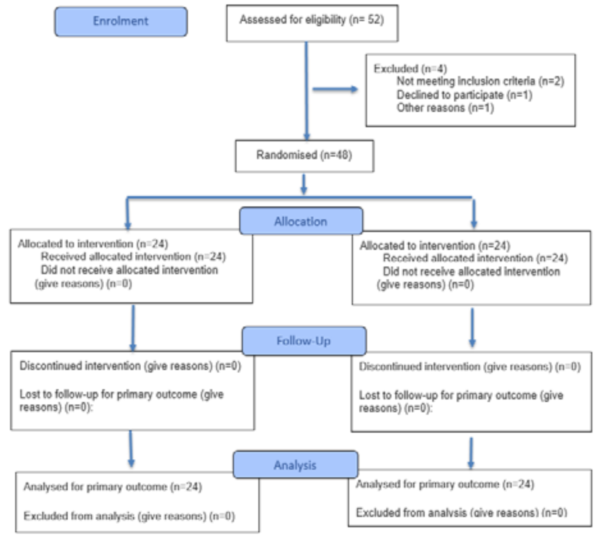

Figure 1: CONSORT Diagram

Results

The demographic features of the participants were similar in Group A and Group B and represented an equal spread of participants in terms of basic physical characteristics. The means for age, weight, height, and body mass index in both groups were nearly the same and remained within the healthy range. Such considerable similarities in baseline physical profiles decrease the risk of any confounding effects and promote high internal validity of the research (Table 1).

In terms of lateral dominance, it mostly prevailed in the form of right-handed with more frequent right shoulder engagement than left. The duration of pain experience was usually from four to eight weeks and less frequently was shorter or longer than mentioned above. Most patients did not have a history of previous shoulder complaints and did not take physiotherapy now of evaluation. The results of diagnosis showed that rotator cuff tendinopathy was the most frequent disorder among patients in both groups, the second position was taken by shoulder impingement, and glenohumeral instability was the rarest condition. Thus, clinical features appeared to be equally spread between the two intervention groups (Table 2).

After the intervention, pain intensity decreased significantly in both groups with the higher mean reduction in Group A compared to Group B. There were positive changes in the performance of the UQYBT in all directions with the increases in the medial, inferolateral and superolateral reach distances. The improvements in the medial and inferolateral directions were slightly better in Group A, while in the superolateral direction, there were no differences between groups. Plank time that was used as an indicator of endurance was significantly improved in both groups after the intervention with the better result in Group A (Table 3).

A statistically significant difference was observed between the groups for pain reduction, with Group A demonstrating a greater mean improvement compared to Group B. In contrast, not statistically significant between-groups were found for upper quarter dynamic balance in the medial, inferolateral, or superolateral reach directions. Although Group A showed slightly greater improvements in medial and inferolateral reaches, and Group B demonstrated a marginally higher improvement in the superolateral direction, these differences were not statistically significant. Similarly, improvements in core endurance, measured by plank time, were greater in Group A; however, the between-group difference was not statistically significant. Overall, only pain reduction showed a significant advantage in favor of Group A, while balance and endurance outcomes were comparable between the two interventions.

Table 1: Baseline Demographic Char

Characteristics	(Group A) n=24	(Group B) n=24
Age (years)	21.75 ± 2.81	21.7 ± 2.92
Weight (kg)	57.95 ± 7.19	57.55 ± 5.09
Height (Feet)	5.18 ± 0.30	5.11 ± 0.21
BMI	21.09 ± 2.43	20.64 ± 1.69

Table 2: Clinical Characteristics of Study Participants by Intervention Group

Variable	Category	Group A (n=24)		Group B (n=24)	
		n	%	n	%
Dominant Arm	Right	20	75.0%	18	75.0%
	Left	4	25.0%	6	25.0%
Injured Arm	Right	21	83.5%	15	62.5%
	Left	3	16.5%	9	37.5%
Duration of Pain	2–4 weeks	4	16.7%	4	16.7%
	4–6 weeks	8	33.3%	8	33.3%
	6–8 weeks	8	33.3%	7	29.2%
	>8 weeks	4	16.7%	5	20.8%
Previous History	Yes	6	25.0%	9	37.5%
	No	18	75.0%	15	62.5%
Current Physiotherapy Tx	Yes	8	33.3%	5	20.8%
	No	16	66.7%	19	79.2%
Shoulder Disorders	Rotator Cuff Tendinopathy	11	41.7%	8	33.3%
	Shoulder Impingement	8	33.3%	12	66.7%
	Glenohumeral Instability	7	29.2%	4	16.7 %

Table 3: Pre-Post Intervention Analysis of Outcome Measures in Both Groups

Outcome Measure	Group A				Group B			
	Pre	Post	Mean Diff.	*p-value*	Pre	Post	Mean Diff.	*p-value*
VAS	5.8±3.0	2.78 ± 0.40	3.02		5.45±2.20	3.80±0.99	1.65	
UQYBT – Medial Reach (cm)	54.5±9.2	60.8 ± 8.7	6.3		52.8±7.21	56.8±6.6	4.0	
UQYBT – Inferolateral Reach (cm)	65.3±10.1	72.4 ± 9.5	7.1	<0.05	64.5±8.4	70.4±8.1	5.9	<0.05
UQYBT – Superolateral Reach (cm)	62.7 ± 8.5	69.1 ± 7.9	6.4		60.7±8.5	67.3±8.8	6.6	
Endurance (Plank Time, sec)	70.9 ± 5.0	85.4 ± 7.3	14.5		67.4±5.7	79.8±5.6	12.4	

Table 4. Between-Group Comparison (Post-Treatment)					
Outcome		Group A Mean Difference	Group B Mean Difference	P-Value (Between Groups)
VAS (pain)		3.02	1.65	0.047
UQYBT (Balance)	Medial	6.3	4.0	0.66
	Inferolateral	7.1	5.9	
	Superolateral	6.4	6.6	
Endurance (Plank)		14.5	12.4	0.74

Discussion

This study aimed to assess the effectiveness of upper limb progressive resistance training combined with core stability exercises on pain, core muscular endurance, and upper limb balance in cricket fast bowlers with shoulder disorder. The findings demonstrate that both interventions were effective in improving all measured outcomes; however, Group A showed comparatively greater improvements, particularly in pain reduction. Pain intensity significantly decreased in both groups, with a statistically significant between-group difference favoring Group A. This suggests that the intervention applied in Group A was more effective in reducing pain, which may be attributed to improved muscular support, enhanced neuromuscular control, and reduced mechanical stress on the shoulder joint.

Upper quarter dynamic balance improved in all reach directions in both groups. Although Group A demonstrated slightly greater gains in some directions, the between-group differences were not statistically significant. This indicates that both interventions were similarly effective in enhancing shoulder stability and proprioceptive control. Endurance, measured by plank endurance time, also improved in both groups. While Group A showed a greater mean improvement, the between-group difference was not statistically significant, suggesting comparable effectiveness of both protocols in improving trunk endurance.

Overall, both interventions were beneficial in managing shoulder disorders, with Group A demonstrating a significant advantage in pain reduction, while balance and core stability outcomes were comparable between groups. This aligns with the findings,[16] who emphasized the role of resistance training in modulating nociceptive input and improving shoulder pain. Similarly, progressive loading of the rotator cuff and scapular stabilizers has been reported to significantly reduce pain in overhead athletes.[17] The addition of core exercises may further enhance pain relief, as proximal stability through core activation reduces stress on the glenohumeral joint.[18]

Athletes undergoing integrated core and shoulder rehabilitation have been shown to experience more rapid pain resolution and return to sport.[19] A randomized trial by Shanahan et al. also supports the superior pain relief observed in programs combining regional interdependence principles, confirming the findings of the present study.[20]

Significant improvements in upper limb dynamic balance were observed in both groups, with comparatively greater gains in Group A. The Upper Quarter Y Balance Test reflects functional stability and neuromuscular control, both of which are influenced by scapular strength and trunk stability. Recent studies have demonstrated that resistance and proprioceptive training enhance upper quarter balance performance.[21,22] Moreover, integrating core stabilization with shoulder rehabilitation improves kinetic chain efficiency, leading to better reach distance and control during dynamic tasks.[23,24] Trunk stability has also been identified as a key contributor to distal limb control, supporting the enhanced balance outcomes observed in the group receiving combined training. Improved dynamic balance may additionally reflect reduced injury risk, as trunk control has been identified as a predictive factor for upper extremity injury in overhead athletes.[23]

Core endurance, assessed through plank duration, improved significantly in both groups, with greater gains in the group that received additional core-focused training. These findings are consistent with studies 36–40 indicating that structured trunk stabilization programs enhance muscular endurance and postural control. Systematic reviews.[25,26] have concluded that core stability training improves trunk coordination and overall athletic performance. In rotational sports such as cricket, enhanced core endurance facilitates effective force transfer across the kinetic chain, thereby supporting shoulder function. Furthermore, plank-based training has been shown to improve spinal stability and neuromuscular control, which are essential for high-demand athletic movements.[27]

Collectively, the literature supports the present findings that combined resistance and core stabilization training not only reduces pain but also enhances dynamic balance and muscular endurance, contributing to improved functional outcomes in individuals with shoulder disorders.

Recommendations: Clinicians should consider incorporating trunk stabilization into shoulder rehab protocols. Future studies should explore long-term outcomes, larger sample sizes, and sport-specific performance metrics to further validate these results.

Conclusion

Both interventions had a positive impact on pain, upper limb dynamic balance, and core endurance of the individuals with shoulder problems. However, the reduction in the level of pain was more prominent in group A, but the improvements in balance and core stability turned out to be similar for both groups. These results demonstrate the importance of combining shoulder exercises with core exercises.

Conflict of Interest: None

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Data Availability Statement: The datasets generated and/or analysed during the current study are not publicly available due to ethical, legal, and participant confidentiality considerations but may be available from the corresponding author upon reasonable request, subject to institutional approval where applicable.

Disclaimer: We authors want to declare that we used AI-assistant tools in this article for improving language. We authors are fully responsible for the accuracy, originality, integrity, and scientific validity of this article.

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