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Combined Effect of Core and Scapular Stabilization Exercises on Position of Scapula and Bowling Speed among Cricket Bowlers with Scapular Dyskinesis: A Pilot Study

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SUMMARY

Background and objective. Scapular dyskinesis refers to the deviation in the normal positioning of the scapula. Its prevalence among cricket fast bowlers is estimated to be around 10%. The relationship between scapular and core stability is crucial, as weakness of scapular muscles which is the main cause for scapular dyskinesis, subsequently reduces core strength. This not only impacts bowling performance but is often overlooked in the management of scapular dyskinesis. So, the objective of this study is to investigate how a combination of core and scapular stabilization exercises influences both scapular position and bowling speed in cricket fast bowlers with scapular dyskinesis.

Methods. Twenty asymptomatic professional cricket fast bowlers with scapular dyskinesis, aged 18-25 years, volunteered to take part in the study. Participants were randomly assigned to two groups: GROUP A (Experimental Group) received a combination of core stability exercises and scapular stabilizing exercises, while GROUP B (Control Group) underwent scapular stabilizing exercises only. Bowling speed was quantified using a Radar Gun, and the scapular position was evaluated using the Lateral Scapular Slide test pre-treatment, 6th-week post-treatment, and follow-up at 10th week.

Results and conclusions. Cricket fast Bowlers who received combined core and scapular stability Exercises demonstrated significant improvement in Bowling speed (P-value < 0.001) and Lateral scapular slide test (p < 0.001) compared to the cricket fast bowlers who received only scapular stability exercises.

KEY WORDS

Scapular dyskinesis; core stability; scapular stability; bowling performance.

INTRODUCTION

Scapular Dyskinesis is characterized by changes in the scapula's position and the patterns of scapular motion in relation to the thoracic cage (1). The scapula serves as a pivotal structure for transmitting substantial forces and high energy from the lower body and trunk, which are the primary sources of power and energy, to the arms and hands, which function as the means of delivering this energy and force.

The proper functioning of the scapula is highly reliant on the performance of the scapular muscles. Strong scapular muscles are a fundamental requirement to ensure optimal stability and effective movement of the scapulothoracic joint (2). Evidence suggests that a lack of strength in the muscles responsible for stabilizing the scapula can result in changes in the scapula's alignment relative to the thoracic rib cage and in the way it moves in relation to the thoracic cage. These alterations in scapular positioning and motion patterns are called scapular dyskinesis. Bowling in cricket involves intricate movements that demand coordination between the upper and lower limbs to deliver a ball with proper technique. Research indicates that the prevalence of Scapular Dyskinesis in cricket bowlers is 10% (3). Core stability is defined as the ability to control the position and movement of the trunk over the pelvis, enabling the efficient generation, transmission, and management of force and motion to the extremities during integrated athletic activities (4). Sporting activities like bowling demand synchronization between the upper and lower limbs. The core serves as the central connection between these two segments, and maintaining stability in this region is essential for achieving peak athletic performance and reducing the risk of injuries. A strong core enables an athlete to efficiently transmit the forces produced by the lower extremities, through the torso, and into the upper extremities. Conversely, a weak core is thought to impede energy transfer, potentially leading to decreased athletic performance and an increased risk of injury (5).

The effective control of the scapula relies on the strength of the core muscles, enabling athletes to coordinate the movement of both the lower and upper extremities harmoniously. Consequently, a lack of control in the scapular region may be interconnected with diminished control in the core muscles, which are responsible for stabilizing the extremities. So, it is crucial to focus on core stability when addressing scapular dyskinesis (6). Studies have also demonstrated a significantly higher EMG activity in the Scapular Muscle during Core Exercise (7). Scapular and core muscles play an important role in the transfer of energy and are required for optimal athletic performance and injury prevention. Scapular stabilization exercises, which involve a combination of stretching and strengthening, enhance both the strength of scapular muscles and the awareness of joint positioning. The serratus anterior and trapezius muscles function as stabilizers for the scapula. Specifically, the serratus anterior is crucial for influencing scapular external rotation and posterior tilt, while the lower trapezius contributes to stabilizing the scapula, the weakness of these muscles contributes to altered scapular position (8-10). Previous studies (6) have shown that diminished scapular control in the scapular region is interconnected with diminished control in the core muscles, which are responsible for stabilizing the upper extremity. Substandard core stability increases the risk of athletes' upper limb injury and performance. So, the present study aims to find the Combined effect of Core and scapular stabilization exercises on the bowling Speed and Position of the scapula among cricket fast bowlers with scapular dyskinesis.

METHODS

Study population, recruitment, and eligibility criteria

The current study included twenty Cricket Fast bowlers with Scapular dyskinesis. Approval was obtained from the Institutional Ethics Committee (IEC) of RV College of Physiotherapy (Ref: RVCP/RESEARCH/283A – date of approval: 29 August, 2022). Permission from the authorities to carry out the study was obtained. An informed written consent from the subjects was obtained after explaining the purpose of the study. 20 Professional Cricket Fast Bowlers with Asymptomatic scapular dyskinesis aged between 18-25 years willing to participate were recruited. Cricket Fast bowlers with low back pain, Lower Limb radiating pain, shoulder pathology, neck pain, neurological problems, history of the spinal, upper limb, or lower limb surgeries, and referred pain were excluded. Procedures were explained to all the subjects and informed consent was obtained. Demographic data of the subjects such as age, height, and body mass index were measured and recorded. The subjects were screened for Scapular Dyskinesis using the Scapular Dyskinesis test.

The Scapular Dyskinesis Test commenced with participants positioning their arms alongside their bodies, elbows extended, and shoulders in a neutral rotation. Participants were instructed to smoothly raise their arms overhead, adopting a "thumbs-up" position, maintaining the elevation for a 3-second count, followed by a controlled descent to a 3-second count (11). Subsequently, the test was repeated with participants holding dumbbells corresponding to their body weight: 1.4 kg (3 lb) for those weighing less than 68.1 kg (150 lb) and 2.3 kg (5 lb) for those weighing 68.1 kg or more. Any deviation from the normal scapular position was carefully observed and documented. The evaluation of Scapular Dyskinesis involved categorizing it as normal, subtle Dyskinesis, or obvious Dyskinesis based on the observed outcomes of the Scapular Dyskinesis Test. Cricket bowlers with subtle and Obvious categories were included in the study. Cricket fast bowlers with scapular dyskinesis were randomly divided into two groups (Group A and Group B) each consisting 10 cricket fast bowlers using a Random number Generator application.

Randomization and blinding

A computer-generated sequence of random numbers was employed for the randomization process which randomly assigned participants to either of the two therapies. Throughout the study, this sequence was meticulously recorded in a securely password-protected Excel table and maintained confidential from collaborators.

While group allocation to physical therapists or participants was not concealed, this was attributed to the inherent dissimilarities in the exercise programs. However, to ensure objectivity, outcome assessors and data analysts remained unaware of treatment allocations. They were not involved in participant recruitment, treatment assignment, or intervention administration. Participants were explicitly instructed not to disclose details of their intervention to outcome assessors, thus upholding the blinding protocol.

Both the groups were assessed for Bowling speed by Radar Gun and Scapular dyskinesis (Position of the scapula) by lateral scapular glide test on Day 1(Pre-Intervention), 6th Week (Post-intervention), and 10th Week (follow-up)

Bowling speed was assessed with a Radar Speed Gun positioned behind the nets at the batting end, aligned with the approximate height of the ball release and in line with the stumps placed at the batting end. Participants were instructed to bowl in their natural actions in the nets, aiming to deliver the ball as swiftly as possible towards the stumps. Each participant bowled three balls, and the resulting bowling speeds were measured. The averages of these three measurements were then recorded (12).

Lateral Scapular slide test included measurements from the inferior angle of the scapulae to the spinous process of the thoracic vertebrae, all on the same horizontal plane, in three distinct positions:

- In Position 1, the shoulder is maintained in a neutral position, with the arms resting comfortably at the sides.
- Transitioning to Position 2 involves medial rotation of the humerus and a 45-degree abduction, achieved by placing the patient's hands around the waist.
- In Position 3, the humerus is subjected to maximal medial rotation, combined with a 90-degree abduction (13). The differences between both sides in all 3 test positions were documented

GROUP A (Experimental Group) received core stability exercises and scapular stabilizing exercises and GROUP B (Control Group) received only scapular stabilizing exercises.

Core Stability exercises included Abdominal 'tuck in' in the crook lying position, Abdominal 'tuck in' in sitting position with tactile cue on back, Abdominal 'tuck in' in a quadruped position, Bridging on the floor without leg extension, Bird dog exercise in a quadruped position, Planks, Abdominal crunches on the floor (hands behind head), Back bridging on the Swiss ball without leg rise, Wall squat with a Swiss ball, Abdominal crunches on Swiss ball (hands over chest) Back bridging on a Swiss ball with leg raise

Scapular Stability Exercises included Scapular clock exercises, Wall washes, corner stretch- sleeper stretch, lawn-mover and robbery maneuver, Black burn retraction, Alternating punches with TheraBand in diagonal, upward, and downward directions, scapular push-ups and Low row exercises, TheraBand Exercises- Scaption, standing boxer punch, standing dynamic hug, Bilateral external rotation with abduction 0 degrees, rowing exercises.

All the exercises were performed with a Frequency of 4 times/weeks for 6 weeks. Three sets for each exercise with

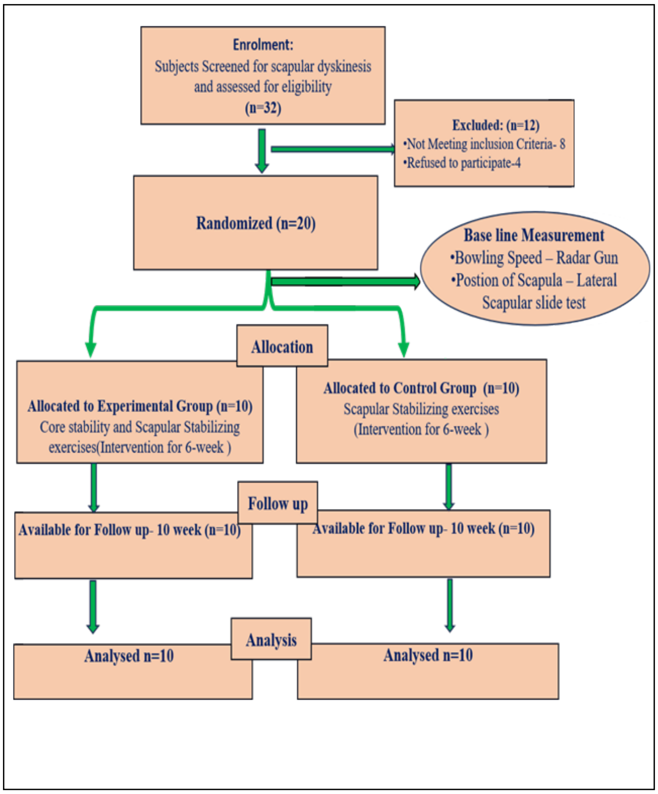

Figure 1. Flow chart showing the methodology.

10 repetitions in each set and intermittent rest in between. At the 10th week follow-up was done (**figure 1**).

Statistical analysis

The data was analyzed using descriptive statistics and inferential statistics:

- Descriptive statistics - The quantitative variables are described by the means of descriptive statistics like mean, median, and standard deviation with standard error of the mean and 95% confidence interval for the mean. Wherever necessary the results are presented graphically.
- Interferential statistics – Repeated measures of ANOVA are applied within the Group. Students Unpaired t-test is applied to test the difference in means between groups.

RESULTS

Results are reported in **tables I-III** and **figures 2-5**.

DISCUSSION

This study compared the combined effectiveness of core stability exercises and scapular stabilization exercises *versus* scapular stability exercises alone on Bowling speed and position of the scapula in cricket fast bowlers with scapular dyskinesis. The findings revealed that the combined program resulted in more substantial improvements in both bowling speed and scapular position compared to the group that only received scapular stabilization exercises.

The scapula plays a critical role in ensuring optimal shoulder function, where its anatomy and biomechanics work together to produce efficient movement. Normally, the scapula serves as a stable foundation, allowing for proper glenohumeral mobility. The stability of the scapulothoracic joint is largely dependent on the surrounding muscles, which must dynamically position the glenoid for efficient glenohumeral movement. However, when there is weakness or dysfunction in the scapular muscles, normal scapular positioning and mechanics can become compro-

Table I. Comparison of baseline clinical variables (Age, height, weight, and BMI among the experimental and control group).

Variables	Experimental Group	Control Group	Total	P-value
Age in years	20.2 ± 2.1	20 ± 1.89	20.1 ± 1.94	0.825
Height(m)	1.77 ± 0.04	1.77 ± 0.04	1.77 ± 0.04	0.795
Weight (kg)	70.78 ± 2.88	71.38 ± 2.53	71.08 ± 2.66	0.627
BMI	22.53 ± 1.56	22.82 ± 0.78	22.67 ± 1.21	0.617

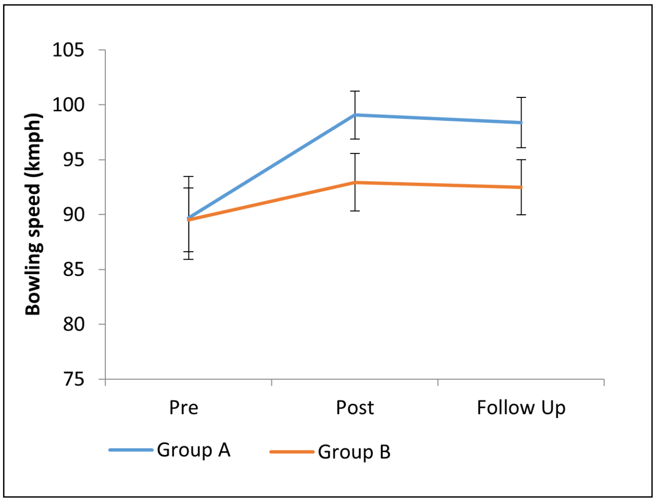

Figure 2. Bowling speed (kmph): comparison within and between experimental and control

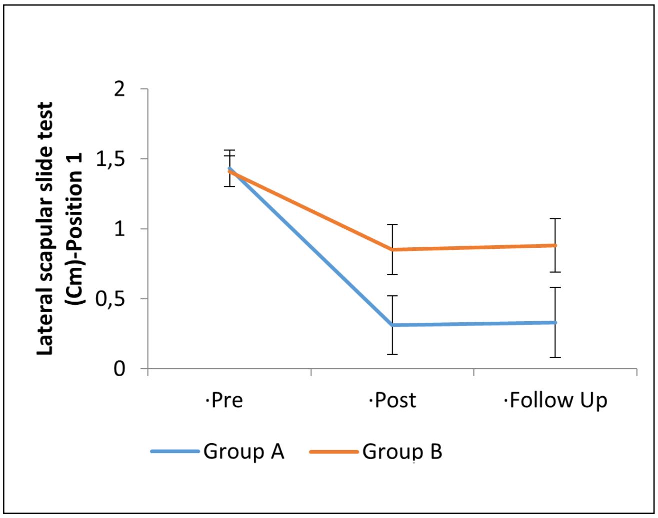

Figure 3. Lateral scapular slide test (cm): comparison within and between experimental and control group in position 1.

Table II. Bowling speed (kmph): comparison within and between experimental and control group.

Variables	Experimental Group	Control Group	Total	P-value
Pre	89.68 ± 3.77	89.51 ± 2.92	89.59 ± 3.28	0.915
Post	99.07 ± 2.18	92.93 ± 2.62	96 ± 3.93	< 0.001**
Follow Up	98.38 ± 2.31	92.48 ± 2.52	95.43 ± 3.83	< 0.001**
Repeated Measures F	183.69	39.078	59.435	-
P-value	< 0.001**	< 0.001**	< 0.001**	-

**Statistically significant.

Table III. Lateral scapular slide test (cm): comparison within and between experimental and control group.

Lateral scapular slide test (Cm)	Group A	Group B	Total	P-value
Position 1				
Pre	1.43 ± 0.13	1.41 ± 0.11	1.42 ± 0.12	0.719
Post	0.31 ± 0.21	0.85 ± 0.18	0.58 ± 0.33	< 0.001**
Follow Up	0.33 ± 0.25	0.88 ± 0.19	0.61 ± 0.35	< 0.001**
Repeated Measures F	254.394	59.148	104.762	-
P-value	< 0.001**	< 0.001**	< 0.001**	-
Position 2				
Pre	1.93 ± 0.33	1.91 ± 0.31	1.92 ± 0.31	0.890
Post	0.91 ± 0.26	1.34 ± 0.28	1.13 ± 0.34	0.002**
Follow Up	0.92 ± 0.24	1.36 ± 0.33	1.14 ± 0.36	0.003**
Repeated Measures F	92.082	147.911	105.540	-
P-value	< 0.001**	< 0.001**	< 0.001**	-
Position 3				
Pre	2.25 ± 0.22	2.26 ± 0.22	2.26 ± 0.21	0.920
Post	1.04 ± 0.2	1.44 ± 0.24	1.24 ± 0.29	< 0.001**
Follow Up	1.07 ± 0.18	1.47 ± 0.21	1.27 ± 0.28	< 0.001**
Repeated Measures F	236.801	152.436	225.471	-
P-value	< 0.001**	< 0.001**	< 0.001**	-

**Statistically significant.

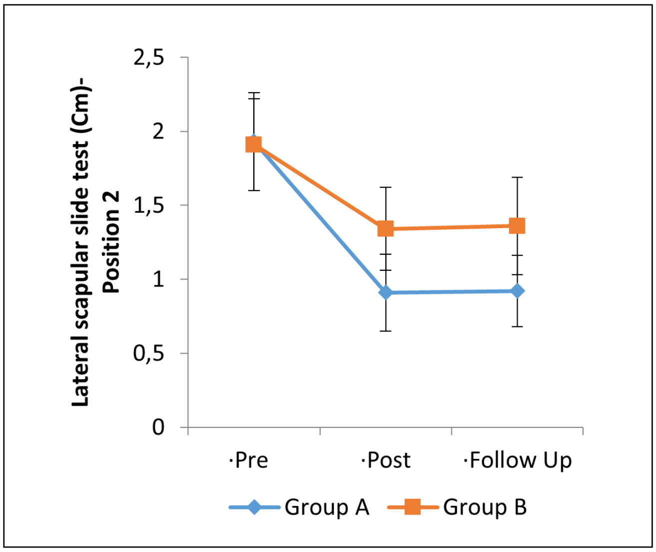

Figure 4. Lateral scapular slide test (cm): comparison within and between experimental and control group in position 2.

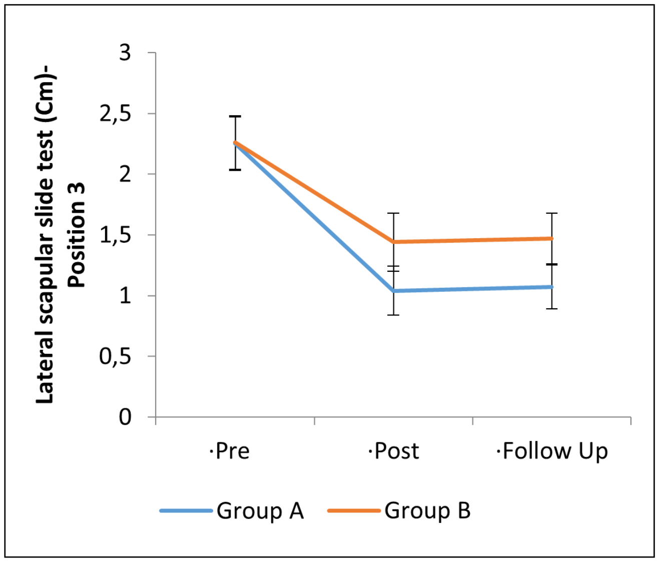

Figure 5. Lateral scapular slide test (cm): comparison within and between experimental and control group in position 3.

mised. This failure in scapular stabilization can lead to inefficient shoulder function, decreased neuromuscular performance, and an increased risk of shoulder injury. Scapular dyskinesis is thought to be more prevalent among overhead athletes due to their heavy reliance on unilateral upper extremity function (14).

In a systematic review by Matthew *et al.*, twelve studies involving 1,401 athletes (1,257 overhead and 144 non-overhead; average age 24.4 ± 7.1 years; 78% male) were analyzed. The review found that scapular dyskinesis was more common in overhead athletes, with a prevalence of 61%, compared to 33% in non-overhead athletes (15).

In the study by Sathya *et al.*, the scapular position in cricket bowlers without shoulder issues was evaluated using the Modified Lateral Scapular Slide Test. The findings indicated that abnormal lateral displacement of the scapula was more commonly observed in the unloaded Scaption position among pace bowlers (16).

Similarly, in Surbhi Abhange *et al.*'s study on the "Prevalence of Scapular Dyskinesia Among Cricket Bowlers," 30 male cricket bowlers aged 18 to 35 years, each with at least two years of bowling experience, were assessed for scapular dyskinesia using the Scapular Dyskinesia Test. The study found that 10% of the fast bowlers exhibited scapular dyskinesis (17).

Scapular dyskinesis has the potential to disrupt shoulder mechanics, impacting the efficiency of force generation and transmission throughout the bowling motion. This alteration in mechanics can impair the coordination and timing of shoulder movements, which are crucial elements for achieving Bowling speed.

Several studies, conducted by multiple researchers (18), have explored the effectiveness of rehabilitation programs centered around scapular stabilization to mitigate and manage such concerns. For instance, De Mey *et al.* (19) research unveiled that a six-week training regimen resulted in significant improvements in the activation of scapular muscles among overhead athletes, consequently enhancing their performance.

Moreover, Neeraj Singh and Pragya's (20) studies demonstrated that scapular stabilizing exercises contributed to enhanced throwing performance among baseball players exhibiting signs of scapular dyskinesis

A study by Elif Turgut (21) demonstrated improvement in scapular kinematics following scapular stabilization exercise. Pradeep Shankar's (22) study highlighted the effectiveness of a scapula stabilization exercise protocol in addressing Scapular type-2 Dyskinesia, as assessed through the lateral scapular slide test.

All these studies demonstrated the effect of scapular stabilizing exercises among different overhead athletes in improvising their athletic performance which supports the current study stating the control group who received scapular stability exercises improved bowling speed and position of the scapula.

However, the current study not only showcased the efficacy of scapular stability exercises in ameliorating scapular dyskinesis and enhancing bowling speed, thereby contributing to improved overall performance but highlighted that incorporating core stability exercises alongside scapular stability exercises resulted in superior improvements in scapular dyskinesis and bowling speed compared to focusing solely on scapular stabilization.

Core stability refers to the ability to control the position and motion of the trunk in coordination with the pelvis and lower extremities. This enables the core to generate, transfer, and regulate force and motion to the distal segments (23). Dynamic stability of the spine involves the functional utilization of muscular strength and endurance to effectively control the spine during activities that are both functional and athletic (24). Enhanced core stability has been scientifically demonstrated to support optimal body mechanics, enabling athletes to maximize the generation of force while minimizing the stress placed on proximal joints (4). Considering the significance of kinetic chain principles in everyday activities and especially during intricate sports movements like bowling adaptations in the scapulothoracic joint may influence core muscle strength and movement quality within the kinetic chain, consequently impacting the outcome. The stability of both scapular and core muscles is linked to both injury risk and performance. Additionally, there is a mutual influence between scapular and core muscle endurance. In a prior study conducted by Gamze Cobanoglu *et al.* (25), it was discovered that core muscle endurance exhibited a positive correlation with scapular muscle endurance indicating weak scapular muscle can influence core muscle strength. Shuang Qin Etal (26) study demonstrated combined core stability training and scapular muscle training over five weeks helped improve the scapular muscle activation, scapular muscle balance ratios during shoulder movement, and the function overhead athletes with scapular dyskinesis.

Combined core and scapular stability had a significant effect and the mechanism could be due to the thoracolumbar fascia which covers the trunk like a band. The thoracolumbar fascia serves as a vital connection between the lower and upper extremities, bridging the superior/inferior and right/left components of the kinetic chain (27). Comprising anterior, middle, and posterior layers, the superficial lamina of the posterior layer originates from the latissimus dorsi muscle, while the transversus abdominis extensively attaches to the middle and posterior layers (28). Progressing posteriorly, the superficial lamina forms a fascial cover containing key muscle groups such as pectoralis major and minor, rhomboideus major and minor, trapezius, and serratus anterior. Continuing towards the caudal end, it extends to the latissimus dorsi and gluteus maximus (17, 29). These layers play crucial biomechanical roles as mediators in load and energy transfer between the upper and lower extremities and the abdominal wall and lumbopelvic region (30).

Studies emphasizing muscle activation patterns during sporting activities have underscored the significance of core stability. It has been observed that, in response to swift arm movements, muscle activation patterns initiate in the lower extremity, progress through the trunk, and extend to the arm (31). This sequential force development, starting from the ground through the core to the extremities, has been demonstrated in sports like tennis (32).

Enhanced core stability not only contributes to increased scapular muscle stability but also reduces the risk of shoulder injuries. This, in turn, ensures normal functioning of the upper extremity and enhances the performance of bowlers. To mitigate injury risks and optimize performance, integrating both core and scapular stabilizing exercises is imperative for cricket bowlers dealing with scapular dyskinesis.

CONCLUSIONS

The optimal function of the scapula, scapulothoracic muscles, and core muscles collectively play a pivotal role in the overall functionality of the upper extremity. Effective scapular control relies on the strength of the core muscles, enabling athletes to synchronize the movement of the lower and upper extremities. Consequently, a lack of control in the scapular region may be linked to a deficiency in core stability, responsible for stabilizing the extremities. In the kinematics of bowling, the force generated from the legs and trunk is transferred to the upper extremity through the scapula. Weakening of the scapular muscles alters the core strength, thereby influencing the biomechanics of the upper extremity. This alteration results in excessive stress and forces being applied to both proximal and distal components within the kinetic chain. The current study illustrated that incorporating combined core and scapular stability exercises led to a significant improvement in bowling speed and a reduction in scapular dyskinesis compared to relying solely on scapular stability exercises.

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None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

PD: conceptualization, methodology, writing – original draft. SP: writing – review & editing, supervision.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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