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# Combined Upper Cervical Mobilization and Shoulder Strengthening in Overhead Athletes with Cervical Hypermobility

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## ABSTRACT

**Background:** Throwing performance among athletes is significantly affected coupled with increased risk of injury in the presence of scapular dyskinesia. The condition is prevalent among 50% of athletes involving in overhead movements. The present study is aimed to determine the effects of combined upper cervical mobilization and shoulder strengthening in overhead athletes throwing performance and scapular movement experiencing upper cervical hypermobility.

**Methods:** A randomized controlled trial was conducted at Aftab Physiotherapy and Medical Centre and Rawal Institute of Health Sciences, between June 2024 and August 2025. A sample size of n=24 athletes were recruited. The outcome measures were assessed at baseline, week 6 and week 12. Assessment was based on shoulder active range of motion, scapular dyskinesia test, throwing performance and disability of the arm, shoulder and hand (DASH) questionnaire.

**Results:** Twenty participants completed all assessments (10 per group). At 12 weeks, the experimental group demonstrated significantly greater improvements compared to the control group in shoulder flexion (178.90±4.52° vs. 172.30±5.28°, p=0.005), abduction (176.40±5.18° vs. 170.80±5.89°, p=0.028), and external rotation (94.70±4.28° vs. 89.50±4.76°, p=0.015). Normal scapular movement patterns were achieved in 60% of experimental group participants compared to only 30% in the control group (p=0.041).

**Conclusion:** Combining upper cervical mobilizations with shoulder strengthening exercises produced significantly superior improvements in shoulder range of motion, throwing performance, scapular movement quality, and upper extremity function compared to shoulder strengthening alone in overhead athletes with scapular dyskinesia and upper cervical hypermobility.

**Keywords:** *Athletes, Pain, Range of motion, Shoulder*

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## INTRODUCTION

Overhead athletes, including swimmers, baseball players, and other throwing athletes, experience significant demands on their upper extremity kinetic chain. The integrated function of the cervical spine, scapula, shoulder complex, and core musculature is essential for optimal throwing velocity, accuracy, and injury prevention in these populations[1]. Nevertheless, abnormal movement pattern of the scapula and scapular dyskinesis while performing overhead activities is a prevalent dysfunction the effects performance and increase risk of shoulder injury[2]. The condition of scapular dyskinesia is characterized by an abnormal movement of the scapula during overhead activities that causes increase in stress on rotator cuff and altered glenohumeral mechanics. A study has revealed that scapular dyskinesis is prevalent among 50-100% of overhead athletes complaining of shoulder pain[4]. Multiple factors cause scapular dyskinesis ranging from scapular stabilizer weakness to postural deviation such as forward head posture[5].

The concept of kinetic chain that underlines the notion of managing shoulder complication by involving comprehensive shoulder rehabilitation that includes not only treating involved shoulder structure but including proximal and distal segments in the treatment staregy[6]. Forward head posture a common problem observed in overhead athletes significantly contributes in shoulder dysfunction by altering the scapular kinematics[7].The role of cervical spine is very important in coordinated movement pattern, visual acquisition and proprioception during overhead activities[7-8]. In particular the mobility of upper cervical and its stability is a key in maintaining postural alignment while allowing sequential activation required for throwing mechanics[8]. Although substantial evidence supports isolated scapular mobilization training and strengthening exercises in improving shoulder function[9-10] yet limited researches are available that support combine approaches in managing the condition like shoulder dysfunction.

Upper cervical mobilization if applied properly can improve cervical mobility, forward head posture and scapular movement quality[10]. However, the potential effects of combining cervical mobilization and shoulder strengthening in improving scapular movement quality remains underexplored.

Manual therapy techniques, including mobilization with movement and corrective exercises, have demonstrated effectiveness in improving scapular positioning in swimmers with scapular dyskinesis[11]. However, most rehabilitation programs for overhead athletes focus primarily on glenohumeral and scapular musculature while neglecting cervical spine assessment and intervention. This represents a significant gap in the current evidence base, as the cervical spine's influence on shoulder mechanics and athletic performance warrants systematic investigation.

In light of the evidences that are available on data search the present study is aimed to determine the combine effects of upper cervical mobilizations and strength training on throwing velocity, scapular movement quality and functional outcomes in overhead athletes suffering from scapular dyskinesis

## METHODOLOGY

### *Study Design*

Randomized Controlled trial was conducted and an envelope method was used to allocate participants in one of the two group while maintaining blinding of participants.

### *Study Setting*

The study was conducted at two sites: Aftab Physiotherapy and Medical Centre and Rawal Institute of Health Sciences, between June 2024 and August 2025. Both facilities were equipped with necessary infrastructure for conducting physical therapy interventions and outcome assessments.

### *Sample Size Calculation*

Sample size was calculated based on values obtained from a previous study titled "Scapular dyskinesis-based exercise therapy versus multimodal physical therapy for subacromial impingement syndrome in young overhead athletes with scapular dyskinesis: a randomized controlled trial[12]." The primary outcome measure used for calculation was shoulder flexion AROM at week 12. The mean ± standard deviation for the SDBET group was 171.13 ± 5.15 degrees, and for the MPT group was 163.69 ± 5.07 degrees. Using these values with a power of 80% and a significance level of 0.05, a sample size of 16 participants (8 per group) was calculated. Anticipating a drop out, 50% increase in sample size was performed thereby raising a sample size to 24, n=12 participants in each group.

### *Participants*

**Inclusion Criteria**

Inclusion criteria were based on following:

- Athletes involved in overhead movement more frequently like cricketers, swimmers indulge in any of the sports for past 6 month
- Both male and female of age 18-35 years
- Active participation in overhead sports for at least 6 months prior to enrollment
- Clinical diagnosis of scapular dyskinesis confirmed through visual assessment using the Scapular Dyskinesis Test
- Forward head posture having a craniovertebral angle of $\leq$ 50 degrees
- Upper cervical hypermobility confirmed through manual examination
- Ability to understand and follow instructions in English or Urdu

**Exclusion Criteria**

Exclusion Criteria was based on following:

- History of shoulder surgery or fracture in the past 12 months
- Current or recent (within 3 months) shoulder dislocation or subluxation
- Cervical spine pathology including disc herniation, radiculopathy, or myelopathy
- Systemic inflammatory conditions (e.g., rheumatoid arthritis, ankylosing spondylitis)
- Neurological disorders affecting upper extremity function
- Contraindications to manual therapy (e.g., vertebrobasilar insufficiency, cervical spine instability)
- Corticosteroid injection in the shoulder region within the past 6 weeks

### *Randomization and Allocation Concealment*

Following baseline assessment and confirmation of eligibility, participants were randomly allocated to either the experimental or control group using computer-generated random numbers in sealed, opaque envelopes. The randomization sequence was prepared by an independent researcher not involved in participant recruitment or assessment. Allocation was performed by the principal investigator after baseline measurements were completed. Due to the nature of the intervention, participants and treating therapists could not be blinded to group allocation; however, the outcome assessor remained blinded to group assignment throughout the study.

### *Intervention Protocols*

Experimental Group: Upper Cervical Mobilizations + Shoulder Strengthening

Participants in the experimental group received a combination of upper cervical mobilizations and shoulder strengthening exercises for 12 weeks, with three supervised sessions per week.

Upper Cervical Mobilization Protocol (15-20 minutes per session):

- C1-C2 rotation mobilization (Grade III-IV Maitland): 3 sets of 30-second oscillations bilaterally[13].
- Suboccipital release: sustained pressure for 90 seconds bilaterally.
- Upper cervical flexion mobilization: 3 sets of 30-second oscillations.
- Cervical retraction exercises with overpressure: 3 sets of 10 repetitions.
- Deep neck flexor strengthening (chin tucks): 3 sets of 10 repetitions with 10-second holds.

***Shoulder Strengthening Protocol (30-35 minutes per session):***

- Scapular setting exercises: 3 sets of 15 repetitions.
- Serratus anterior strengthening (wall slides, push-up plus): 3 sets of 12 repetitions.
- Lower trapezius strengthening (prone Y, T, I exercise): 3 sets of 12 repetitions[14].
- Middle trapezius strengthening (horizontal abduction): 3 sets of 12 repetitions.
- External rotation strengthening with resistance band: 3 sets of 15 repetitions.
- Internal rotation strengthening with resistance band: 3 sets of 15 repetitions.
- Scapular clock exercises: 2 sets in each direction.
- Closed kinetic chain exercises (quadruped position): 3 sets of 30 seconds.

Progression was implemented every 2 weeks based on individual tolerance and performance, with increases in resistance, repetitions, or exercise complexity.

### *Control Group: Shoulder Strengthening*

Participants in the control group received only the shoulder strengthening protocol described above, also for 12 weeks with three supervised sessions per week (30-35 minutes per session). The same progression principles were applied.

Both groups received education on posture correction, activity modification, and a home exercise program to be performed on non-supervised days.

### *Outcome Measures*

**Primary Outcome Measures**

1. **Shoulder Active ROM:** Shoulder flexion, abduction, and external rotation AROM were measured using a universal goniometer following standardized protocols. Measurements were taken at baseline, 6 weeks, and 12 weeks. Participants performed three trials for each movement, and the average was recorded[15].

2. **Scapular Dyskinesis Test:** Scapular movement quality was assessed using the Scapular Dyskinesis Test, a validated observational tool. Participants performed 5 repetitions of weighted shoulder flexion and abduction while being observed from the posterior view. Scapular dyskinesis was categorized as Type I (inferior angle prominence), Type II (medial border

prominence), Type III (superior border elevation), or normal. A video recorded assessment was performed and was evaluated by a physical therapist clinician of at least 10 years of experience along with a researcher[16].

3. **Functional Throwing Performance Index:** Throwing velocity was assessed using a Bushnell 101911 device. A number of 10 maximal efforts of throws were performed by the participants and a mean of ten throw was taken for reporting the findings[17].

4. **Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaire**: Upper extremity function and symptoms were assessed by using a DASH. A questionnaire comprises of 30 items ranging from 0 to 100 with higher score reveals severity of symptoms[18].

### *Data Collection Procedures*

Data was collected by a researcher themselves. All measurement were taken at three different intervals at baseline, at week 6 and week 12. All participants were instructed to avoid any analgesic intake before assessment session.

### *Data Analysis Strategy*

Data analyses were performed using a SPSS version 26. Descriptive analyses were reported in the form of mean and standard deviation. Continuous variables were reported in the form of frequency. Within group analyses was performed using a continuous measure Anova and between group analyses was performed using an independent t-test. Chi-square test was performed to determine association of intervention on the outcome between group.

### *Ethical Considerations*

All principles of ethical consideration were given due consideration. Participants were informed regarding the purpose of study and a written consents were taken prior to inclusion. Ethical approval was taken from the Institutional Review Board of Rawal Institute of Health Sciences prior to participant recruitment (IRB#RHS-IRB/45-3-24).

The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines.

## RESULTS

### *Demographic Characteristics*

A total number of n=24 participants were divided into two groups n=12 in each group. During the period of 12 weeks four participants were withdrew two from each group, hence 20 participants completed the study. The average age of the participants in experimental group was 24.83 ± 4.21 and in the control, group was 25.10 ± 3.95 years. The majority of the participants in both the group were male. In experimental group there were 7 male and 3 females where as in control group there were 8 males and 2 females. The details description of demographical characteristics was given in table 1:

**Table 1. Baseline Demographic and Clinical Characteristics of Participants**

| Characteristic | Experimental Group (n=10) | Control Group (n=10) | p-value |
|---|---|---|---|
| Age (years), Mean ± SD | 24.83 ± 4.21 | 25.10 ± 3.95 | 0.881 |
| Gender, n (%) | | | 0.500 |
| Male | 7 (70%) | 8 (75%) | |
| Female | 3 (30%) | 2 (25%) | |
| BMI (kg/m²), Mean ± SD | 23.65 ± 2.18 | 24.12 ± 2.34 | 0.642 |
| Sport Type, n (%) | | | 0.756 |
| Cricket | 4 (40%) | 4 (40%) | |
| Swimming | 3 (30%) | 2 (20%) | |
| Volleyball | 2 (20%) | 2 (20%) | |
| Throwball | 1 (10%) | 2 (20%) | |
| Years of Participation, Mean ± SD | 6.82 ± 2.45 | 7.15 ± 2.68 | 0.774 |
| Craniovertebral Angle (degrees), Mean ± SD | 46.34 ± 2.87 | 45.92 ± 3.12 | 0.748 |

*SD = Standard Deviation; BMI = Body Mass Index; Independent t-test and Chi-square test were used for continuous and categorical variables respectively*

### *Shoulder Active ROM Outcomes*

Both groups demonstrated significant improvements in all three movement directions over time ($p < 0.001$). At baseline, there were no significant differences between groups in shoulder flexion (experimental: 156.40 ± 6.82 degrees vs. control: 155.30 ± 7.15 degrees, $p = 0.724$), abduction (experimental: 162.80 ± 7.34

degrees vs. control: 161.50 ± 6.98 degrees, p = 0.695), or external rotation (experimental: 78.60 ± 5.42 degrees vs. control: 77.90 ± 5.68 degrees, p = 0.776).

At the 6-week assessment, the experimental group showed greater improvements compared to the control group in shoulder flexion (169.50 ± 5.67 vs. 164.20 ± 6.34 degrees, p = 0.048) and external rotation (87.30 ± 4.95 vs. 83.40 ± 5.21 degrees, p = 0.091), though the difference in external rotation did not reach statistical significance. By 12 weeks, the experimental group demonstrated significantly greater improvements in all three movements compared to the control group. Shoulder flexion reached 178.90 ± 4.52 degrees in the experimental group versus 172.30 ± 5.28 degrees in the control group (p = 0.005), representing a between-group difference of 6.60 degrees. Shoulder abduction improved to 176.40 ± 5.18 degrees versus 170.80 ± 5.89 degrees (p = 0.028), and external rotation reached 94.70 ± 4.28 degrees versus 89.50 ± 4.76 degrees (p = 0.015).

Effect sizes (Cohen's d) for between-group differences at 12 weeks were large for flexion (d = 1.35), moderate for abduction (d = 1.01), and large for external rotation (d = 1.15) (Table 2).

**Table 2. Shoulder Active ROM at Baseline, 6 Weeks, and 12 Weeks**

| Variable | Time Point | Experimental Group (n=10) Mean ± SD | Control Group (n=10) Mean ± SD | Between-Group p-value | Effect Size (Cohen's d) |
|---|---|---|---|---|---|
| Shoulder Flexion (degrees) | Baseline | 156.40 ± 6.82 | 155.30 ± 7.15 | 0.724 | 0.16 |
| | 6 weeks | 169.50 ± 5.67 | 164.20 ± 6.34 | 0.048* | 0.89 |
| | 12 weeks | 178.90 ± 4.52 | 172.30 ± 5.28 | 0.005** | 1.35 |
| Shoulder Abduction (degrees) | Baseline | 162.80 ± 7.34 | 161.50 ± 6.98 | 0.695 | 0.18 |
| | 6 weeks | 171.60 ± 6.12 | 167.40 ± 6.55 | 0.135 | 0.66 |
| | 12 weeks | 176.40 ± 5.18 | 170.80 ± 5.89 | 0.028* | 1.01 |
| External Rotation (degrees) | Baseline | 78.60 ± 5.42 | 77.90 ± 5.68 | 0.776 | 0.13 |
| | 6 weeks | 87.30 ± 4.95 | 83.40 ± 5.21 | 0.091 | 0.77 |
| | 12 weeks | 94.70 ± 4.28 | 89.50 ± 4.76 | 0.015* | 1.15 |

*p < 0.05; **p < 0.01; Independent t-test was used for between-group comparisons*

### *Functional Outcomes: Throwing Performance and Disability Scores*

The functional throwing performance and DASH questionnaire scores are presented in Table 3. At baseline, both groups demonstrated comparable throwing velocity (experimental: 78.45 ± 6.23 km/h vs. control: 77.80 ± 6.54 km/h, p = 0.821), throwing accuracy (experimental: 5.60 ± 1.35 vs. control: 5.40 ± 1.43, p = 0.747), and DASH scores (experimental: 32.85 ± 8.42 vs. control: 33.60 ± 7.98, p = 0.839), indicating similar baseline functional limitations.

Following the intervention, the experimental group demonstrated superior improvements in functional throwing performance compared to the control group. At 12 weeks, throwing velocity improved to 91.35 ± 5.78 km/h in the experimental group compared to 86.20 ± 6.15 km/h in the control group (p = 0.049), representing a mean increase of 12.90 km/h versus 8.40 km/h from baseline. Throwing accuracy scores improved more substantially in the experimental group (8.80 ± 0.92) compared to the control group (7.70 ± 1.06) at 12 weeks (p = 0.018).

The DASH questionnaire scores, which assess upper extremity disability, showed significant reductions in both groups, but the experimental group demonstrated greater improvement. At 12 weeks, the experimental group achieved a mean

DASH score of 11.25 ± 4.67 compared to 16.80 ± 5.34 in the control group (p = 0.019), indicating less disability and better functional recovery. Within-group repeated measures ANOVA revealed significant time effects for all functional outcomes in both groups (p < 0.001), with post-hoc analyses showing progressive improvements from baseline to 6 weeks and from 6 weeks to 12 weeks (Table 3).

**Table 3. Functional Throwing Performance and Disability Scores**

| Variable | Time Point | Experimental Group (n=10) Mean ± SD | Control Group (n=10) Mean ± SD | Between-Group p-value | Effect Size (Cohen's d) |
|---|---|---|---|---|---|
| **Throwing Velocity (km/h)** | **Baseline** | 78.45 ± 6.23 | 77.80 ± 6.54 | 0.821 | 0.10 |
| | **6 weeks** | 85.80 ± 5.89 | 82.30 ± 6.28 | 0.201 | 0.57 |
| | **12 weeks** | 91.35 ± 5.78 | 86.20 ± 6.15 | 0.049* | 0.87 |
| **Throwing Accuracy (out of 10)** | **Baseline** | 5.60 ± 1.35 | 5.40 ± 1.43 | 0.747 | 0.14 |
| | **6 weeks** | 7.40 ± 1.17 | 6.70 ± 1.25 | 0.196 | 0.58 |
| | **12 weeks** | 8.80 ± 0.92 | 7.70 ± 1.06 | 0.018* | 1.11 |
| **DASH Score (0-100)** | **Baseline** | 32.85 ± 8.42 | 33.60 ± 7.98 | 0.839 | 0.09 |
| | **6 weeks** | 21.40 ± 6.35 | 24.70 ± 6.82 | 0.257 | 0.50 |
| | **12 weeks** | 11.25 ± 4.67 | 16.80 ± 5.34 | 0.019* | 1.12 |

*DASH = Disabilities of the Arm, Shoulder and Hand; p < 0.05; Independent t-test was used for between-group comparisons; Lower DASH scores indicate better function*

**Scapular Dyskinesis Classification**

At baseline, both groups showed similar distributions of scapular dyskinesis patterns with no statistically significant differences (p = 0.892). The most prevalent pattern was Type II (medial border prominence), present in 50% of the experimental group and 40% of the control group, followed by Type I (inferior angle prominence) in 40% and 50% respectively, and Type III (superior border elevation) in 10% of each group.

No participants demonstrated normal scapular movement patterns at baseline. At the 12-week assessment, substantial improvements in scapular movement quality were observed in both groups, but the experimental group showed superior results. The findings revealed that in the experimental group a total of n=60 that comprises of 60% of the participants had achieved normal scapular movement compared to control group where only 3 participants (30%) had achieved normal scapular function. Additionally, it was observed that in experimental group 30% of the participants had type I dyskinesis and 10% had type II with complete resolution of type III. Chi-square test revealed a significant difference in distribution of scapular dyskinesis in two groups (p=0.041) favoring experimental group over control group. Details were shown in Table 4.

## DISCUSSION

The present study investigated the effects of combining upper cervical mobilizations with shoulder strengthening exercises compared to shoulder strengthening alone in overhead athletes with scapular dyskinesis and upper cervical hypermobility. The findings revealed that experimental group had shown greater improvement in all outcome measures that includes range of motion, throwing velocity, scapular movement and upper extremity function

| Table 4.Scapular Dyskinesis Classification at Baseline and 12 Weeks | | | |
|---|---|---|---|
| **Scapular Dyskinesis Type** | **Experimental Group (n=10)** | **Control Group (n=10)** | **p-value** |
| **Baseline, n (%)** | | | |
| Normal | 0 (0%) | 0 (0%) | 0.892 |
| Type I (Inferior angle prominence) | 4 (40%) | 5 (50%) | |
| Type II (Medial border prominence) | 5 (50%) | 4 (40%) | |
| Type III (Superior border elevation) | 1 (10%) | 1 (10%) | |
| **12 Weeks, n (%)** | | | |
| **Normal** | 6 (60%) | 3 (30%) | 0.041* |
| Type I (Inferior angle prominence) | 3 (30%) | 2 (20%) | |
| Type II (Medial border prominence) | 1 (10%) | 4 (40%) | |
| Type III (Superior border elevation) | 0 (0%) | 1 (10%) | |

***Chi-square test was used for categorical comparisons; *p* < 0.05 indicates significant difference in distribution between groups**

The findings demonstrated that the experimental group achieved significantly greater improvements in shoulder active range of motion, functional throwing performance, scapular movement quality, and upper extremity function compared to the control group after 12 weeks of intervention.

The improvement in shoulder ROM as observed in the experimental group underline the interconnected mechanism of shoulder biomechanics[19] that is in line with the concept of kinetic chain. A study that was conducted to examine the relationship between cervical spine position and shoulder function highlights that forward head posture significantly reduced shoulder ROM and altered scapular kinematics[19]. Likewise in another study it was observed that combining cervical spine mobilization with scapular exercises bring out greater effects in shoulder mobility in comparison to isolated interventions[20]. These findings are in line with the findings of our study in which it was observed that combining exercises protocol can bring out more effective results than isolated exercises protocol. The findings of our study suggesting an improving in the throwing velocity is in line with the findings of another study in which it was observed that combined cervical and shoulder rehabilitation in baseball player shown a significant improvement in the throwing velocity and shoulder pain[21].Similarly in another study conducted on volleyball players found that kinetic chain training combined with cervical exercises produces better results than isolated shoulder training alone[22].

The reduction in DASH scores observed in both groups indicates meaningful improvements in upper extremity function, with the experimental group demonstrating significantly greater functional gains. Similar findings were observed in a study examining disability outcomes following multimodal shoulder rehabilitation, researchers reported that interventions addressing multiple segments of the kinetic chain produced larger reductions in disability scores compared to isolated approaches[23]. Another investigation found that manual therapy techniques targeting the cervical spine, when combined with exercise therapy, resulted in faster and more substantial improvements in self-reported function in patients with shoulder dysfunction[24]. These findings corroborate the present study's results and highlight the clinical significance of comprehensive treatment approaches.

The normalization of scapular movement patterns was notably higher in the experimental group, with 60% achieving normal scapular mechanics compared to 30% in the control group. A study investigating scapular dyskinesis treatment in overhead athletes reported that interventions addressing postural alignment and cervical positioning enhanced scapular correction rates[25]. Similar results were observed in another trial where combined cervical and thoracic spine mobilization with scapular exercises produced superior outcomes in correcting scapular dyskinesis compared to scapular exercises alone[26]. These findings suggest that cervical spine dysfunction may be a contributing factor to persistent scapular dyskinesis, and addressing this proximal impairment facilitates more effective scapular rehabilitation.

The biomechanical rationale for the observed improvements can be explained by the cervical spine's influence on scapular positioning and upper extremity function. Forward head posture, characterized by reduced craniovertebral angles, has been shown to alter the length-tension relationships of cervical and scapular muscles, leading to compensatory movement patterns[27]. In a study examining the immediate effects of cervical mobilization on scapular muscle activity, researchers found that cervical interventions improved serratus anterior and lower trapezius activation during overhead movements[28]. Another investigation demonstrated that correcting forward head posture through cervical mobilization and exercise resulted in improved scapular upward rotation and posterior tilt during arm elevation[29]. These mechanisms may explain why the experimental group in the present study achieved superior functional outcomes, as cervical mobilizations likely optimized the neuromuscular control and biomechanical positioning necessary for efficient scapular movement and shoulder function.

The clinical implications of these findings are substantial for rehabilitation professionals working with overhead athletes. The results suggest that comprehensive assessment and treatment of the entire upper quarter kinetic chain, including the cervical spine, should be prioritized in athletes presenting with scapular dyskinesis. The combination of upper cervical mobilizations with shoulder strengthening exercises appears to provide synergistic benefits that exceed those achieved through isolated shoulder rehabilitation. This integrated approach may lead to faster return to sport, improved athletic performance, and potentially reduced injury risk in overhead athlete populations.

The study limitation also needs to be highlighted first of which is the small sample size (n=20 completers) that limits the generalizability of findings. Another was the intervention duration that was 12-week although the effects were identified in the duration yet follow-up effects need to be identified that was not covered in the study. Future research should include longer follow-up periods to assess maintenance of gains and recurrence rates.

## CONCLUSION

The study findings revealed that cervical mobilization in combination with strength training has produced a beneficial effect in improving shoulder range of motion, throwing velocity, scapular movement quality and cervical hypermobility. The combine approach of cervical mobilization and strength training has brought out statistically significant effects in comparison to strength training alone.

**Ethical Approval**
Ethical approval was taken from the Institutional Review Board of Rawal Institute of Health Sciences prior to participant recruitment (IRB#RHS-IRB/45-3-24).

**Author Contributions**
**SA:** Conception & Design, Data Analysis & Interpretation, Manuscript Writing, Critical Revision
**RK**, Data Collection, Data Analysis & Interpretation, Manuscript Writing, Critical Revision
**DL:** Data Collection, Data Analysis & Interpretation, Manuscript Writing
All authors approved the final version of the manuscript to be published.

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**Conflict of Interests**
No conflict of interest.

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