Effects of Elastic Band Resistance Training and Verbal Cueing on Musculoskeletal and Pulmonary Functions in Upper Crossed Syndrome: An 8-week Randomized Controlled Trial

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Abstract

Background and objective: Upper Crossed Syndrome (UCS) is highly prevalent among female university students, exerting multifaceted negative impacts on both musculoskeletal and pulmonary functions. This study aimed to evaluate and compare the therapeutic efficacy of an 8-week elastic band resistance training, a verbal cueing intervention, and their combination on correcting UCS. Methods: Thirty-seven female college students identified with UCS characteristics were randomly assigned to four groups: the elastic band intervention group (Group A, n=10), the verbal cueing intervention group (Group B, n=10), the combined intervention group (Group C, n=10), and the control group (Group H, n=7). Key outcome measures including the Neck Disability Index (NDI), forward head angle (FHA), forward shoulder angle (FSA), vital capacity, and cervical range of motion (CROM) were assessed at baseline and post-intervention. Results: Post-intervention analyses revealed that while all three experimental groups exhibited improvements, Group A demonstrated significant superiority over the control group in NDI, FSA, vital capacity, and multiple directions of CROM ($p<0.050$). Furthermore, Group A significantly outperformed Group B in NDI, vital capacity, and bilateral lateral flexion of the cervical spine ($p<0.050$). The combined intervention (Group C) showed significant positive outcomes but did not yield a strictly additive structural effect compared to Group A. Conclusion: Although verbal cueing effectively enhances temporary postural awareness, isolated progressive elastic band resistance training is the most effective approach for inducing structural neuromuscular remodeling. It significantly corrects postural deviations, restores cervical mobility, and alleviates mechanical restrictions on the thorax to improve pulmonary function in patients with UCS.

Keywords

Upper Crossed Syndrome, Elastic band resistance training, Verbal cueing, Vital capacity, Cervical range of motion, Muscle imbalance

Introduction

Upper Crossed Syndrome (UCS) is a prevalent musculoskeletal disorder characterized by a specific pattern of muscle imbalance in the cervicothoracic region, clinically presenting as forward head posture, rounded shoulders, and increased thoracic kyphosis. In recent years, with the pervasive use of smartphones and electronic devices, the prevalence of UCS has surged significantly among young adults. Nemati et al. indicated that female university students are particularly susceptible to this postural dysfunction due to prolonged periods of sedentary study and poor ergonomic habits [1]. This chronic abnormal posture not only alters the aesthetic appearance but also induces continuous mechanical stress on the cervical spine, highlighting the urgent need for effective postural management strategies in this demographic.

The multifaceted negative impacts of UCS extend far beyond superficial postural deviations. From a biomechanical perspective, the adaptive shortening of the pectoralis muscles and the weakness of the scapular retractors inevitably lead to severe cervicobrachial pain and a restricted cervical range of motion. More importantly, this altered thoracic configuration exerts a profound detrimental effect on visceral functions. Zhang et al. and Ahmed et al. emphasized that the exaggerated thoracic kyphosis and elevated rib cage associated with UCS significantly limit the expansile capacity of the thorax and the excursion of the diaphragm [2,3]. This structural constraint forces the body into shallow and inefficient breathing patterns, which directly manifests as a substantial reduction in vital capacity and overall pulmonary function. Therefore, addressing UCS is not merely an orthopedic concern but a critical intervention for restoring optimal respiratory and systemic health.

Currently, clinical and rehabilitative management of UCS primarily diverges into two distinct mechanistic pathways. The first approach emphasizes mechanical overload through resistance training, utilizing tools such as elastic bands or weights to physically stretch tight anterior musculature and hypertrophy weakened posterior stabilizers. As Azam et al. noted, targeted resistance training is highly effective in reversing the structural muscle imbalances characteristic of UCS [4]. The second approach focuses on cognitive and neuromuscular recalibration, employing postural awareness techniques, verbal cueing, or pressure biofeedback to consciously correct faulty movement patterns. Bhandary et al. demonstrated that postural awareness interventions yield rapid, short-term relief by actively engaging the central nervous system to reset proprioceptive baselines [5]. Despite the widespread clinical application of both strategies, a significant gap exists in the current literature. Few high-quality randomized controlled trials have directly compared the isolated efficacy of pure mechanical resistance versus pure cognitive cueing. Furthermore, whether a combined approach yields a synergistic therapeutic effect remains a subject of ongoing debate, particularly concerning young female adults whose musculoskeletal systems are subjected to distinct ergonomic stressors.

To address this critical gap, the present study was designed as an 8-week randomized controlled trial aimed at evaluating and comparing the therapeutic effects of elastic band resistance training, verbal cueing, and a combination of both interventions on female university students with UCS. The primary objective was to comprehensively assess changes in subjective neck disability, postural alignment angles, cervical range of motion, and vital capacity across the different intervention modalities. We hypothesized that while all intervention groups would exhibit improvements compared to a non-intervention control group, the progressive elastic band resistance training would provide the most profound structural and functional benefits. Additionally, we hypothesized that the combined intervention might offer an optimized comprehensive outcome by simultaneously addressing both mechanical strength and neuromuscular awareness.

Methods

Study design

This study was designed as an 8-week randomized controlled trial (RCT). The research was conducted at the Panjin Campus of Dalian University of Technology. The overall experimental procedure consisted of three main phases: a baseline assessment before the intervention, an 8-week intervention period for the randomly assigned groups, and a post-intervention assessment to evaluate and compare the outcomes.

Participants

Participants were recruited from female undergraduate students at Dalian University of Technology. Initially, 44 students were screened using a self-administered questionnaire and posture assessment. Ultimately, 37 female students identified with UCS characteristics were included in the intervention phase. The primary inclusion criteria were: (1) presence of typical UCS posture, such as forward head and rounded shoulders; (2) accompanied by neck and shoulder discomfort; (3) positive signs in specific postural assessments (e.g., the earlobe not aligned with the acromion). The exclusion criteria included: (1) refusal to accept the experimental protocol; (2) history of diagnosed pathological neck or shoulder diseases; (3) current participation in other clinical treatments or trials. The 37 participants were randomly assigned to four groups: Group A (elastic band intervention, n=10), Group B (verbal cueing intervention, n=10), Group C (combined intervention, n = 10), and Group H (control group, n=7). All participants voluntarily participated in the study and signed a written informed consent form prior to the experiment.

Interventions

The 8-week intervention programs were detailed as follows:

Group A (elastic band resistance training): Participants performed specific elastic band exercises three times per week. The protocol included pectoralis minor stretching, bent-over rows (targeting the rhomboids), serratus anterior strengthening, and “W” pulls (targeting the middle and lower trapezius). Each exercise consisted of 3 sets of 15 to 20 repetitions with a 15-second rest between sets. Static cervical stretching was also performed, holding the maximum range of motion for 20 seconds. Compliance was monitored via online video check-ins. And all actions are shown in Figure 1.

Group B (verbal cueing intervention): Participants received posture correction cues twice daily via a mobile application. Upon receiving the cue, participants were instructed to perform a self-assessment against a standard posture guideline, correct any deviations, and maintain the proper posture for 30 seconds while mentally repeating the cue.

Group C (combined intervention): Participants underwent both the elastic band resistance training (as in Group A) and the verbal cueing intervention (as in Group B).

Group H (control group): Participants received no specific intervention. They were instructed to maintain their usual daily routines and avoid initiating any new exercise programs during the 8-week study period.

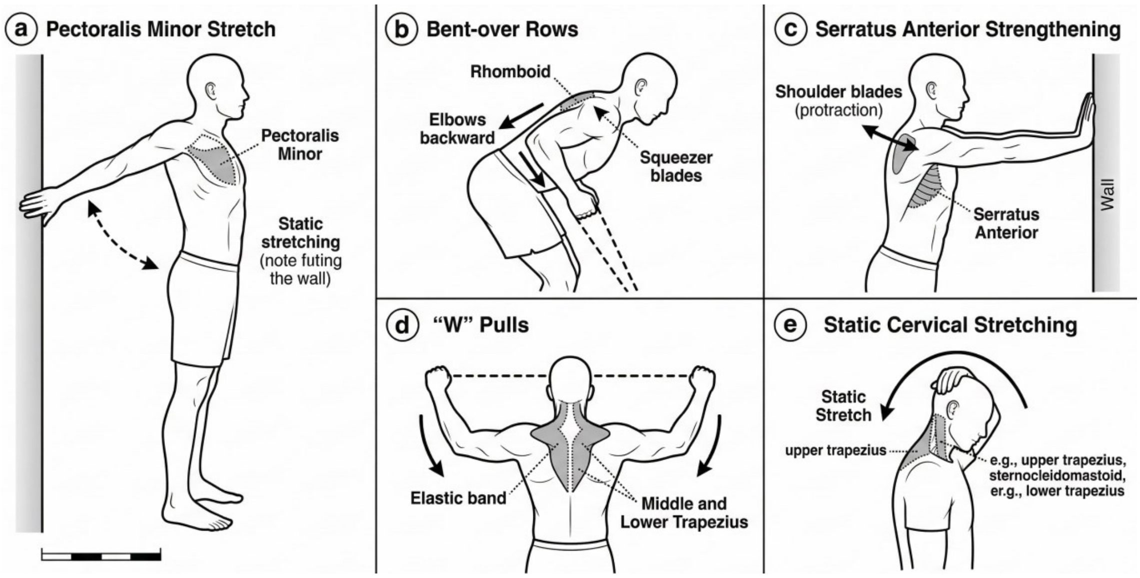

Figure 1. Academic line art illustrating five key UCS intervention exercises with directional arrows and muscle targeting. (a) Pectoralis Minor Stretch, with body rotation away from the wall; (b) Bent-over Rows (targeting Rhomboids), showing elbows pulled backward; (c) Serratus Anterior Strengthening (Serratus Punch), showing forward movement of shoulder blades against a wall; (d) “W” Pulls (targeting Middle and Lower Trapezius), with dynamic downward and backward pulls; (e) Static Cervical Stretching, with a curved arrow indicating lateral flexion direction.

Outcome measures

All outcome measures were assessed at baseline and after the 8-week intervention period.

Postural Assessment: Static posture was evaluated by measuring the forward head angle (FHA) and forward shoulder angle (FSA). Participants were photographed from the sagittal plane. FHA was defined as the angle between a vertical line passing through the seventh cervical vertebra (C7) and a line connecting C7 to the canthus of the eye. FSA was measured as the angle between the C7 vertical line and a line connecting C7 to the highest point of the acromion.

Cervical range of motion (CROM): A standard joint goniometer was used to measure the active CROM in six directions: forward flexion, extension, left and right lateral flexion, and left and right rotation.

Subjective Questionnaires: Pain intensity was assessed using a 100-mm Visual Analog Scale (VAS), with 0 indicating “no pain” and 100 indicating “worst imaginable pain”. Cervical-related disability was evaluated using the Neck Disability Index (NDI), a reliable 10-item questionnaire assessing the impact of neck pain on daily activities.

Pulmonary function: Vital capacity (VC) was measured using an electronic spirometer. Participants were instructed to take a maximal inspiration followed by a maximal expiration in a standing position to avoid postural compensation.

Statistical analysis

Statistical analysis was performed using SPSS version 26.0 software. All continuous variables were first tested for normality and homogeneity of variances prior to all formal analysis. Descriptive statistics were presented as mean ± standard deviation (M ± SD). Paired t-tests were used to evaluate the differences within each group before and after the 8-week intervention. For comparisons among the four groups, a one-way analysis of variance (ANOVA) was conducted. When a significant difference was found, post hoc analyses were performed using Dunnett's test for comparisons between the experimental groups and the control group, and the Least Significant Difference (LSD) test for comparisons among the three experimental groups. A p-value of < 0.050 was considered statistically significant.

Results

Baseline characteristics

Before the 8-week intervention, ANOVA was conducted to compare the baseline characteristics among the four groups (Group A, B, C, and H). The results indicated that, as shown in Table 1, there were no significant differences among the groups regarding basic demographic information including age, weight, and height ($p > 0.050$). Furthermore, baseline assessments for pain intensity (VAS), neck disability (NDI), postural angles (FHA and FSA), vital capacity, and all six directions of cervical range of motion (CROM) showed no statistically significant differences across the groups (all $p > 0.050$). This confirms that the participants in all four groups were well-matched and comparable prior to the implementation of the interventions.

Table 1. Baseline characteristics of the participants prior to the 8-week intervention.

Parameters	Group A (n=10)	Group B (n=10)	Group C (n=10)	Group H (n=7)	F-value	p-value
Demographics						
Age (years)	19.90 ± 1.287	19.50 ± 1.269	19.70 ± 1.494	20.43 ± 1.813	0.606	0.616
Weight (kg)	60.60 ± 10.309	55.30 ± 13.158	60.90 ± 11.474	59.86 ± 10.511	0.513	0.394
Height (cm)	163.20 ± 6.828	162.40 ± 4.351	164.70 ± 6.865	159.86 ± 3.078	1.026	0.676
Subjective questionnaires						
VAS (score)	3.80 ± 2.251	4.80 ± 2.616	4.40 ± 2.716	3.29 ± 1.496	0.664	0.580
NDI (%)	19.80 ± 14.680	18.00 ± 11.624	16.20 ± 10.433	18.57 ± 7.091	0.165	0.919
Postural assessment						
FHA (°)	29.60 ± 7.074	33.90 ± 6.332	34.70 ± 6.219	32.86 ± 6.122	1.196	0.326
FSA (°)	30.30 ± 7.917	30.30 ± 7.818	33.10 ± 5.405	33.14 ± 5.429	0.516	0.674
Pulmonary function						
Vital capacity (mL)	3088.40 ± 558.498	2389.50 ± 296.900	2730.40 ± 596.070	2842.29 ± 401.290	2.364	0.237
Cervical range of motion						
Forward flexion (°)	36.50 ± 9.144	37.20 ± 12.630	35.30 ± 12.597	41.29 ± 7.740	0.436	0.729
Extension (°)	38.50 ± 8.396	38.10 ± 7.978	37.50 ± 9.501	42.43 ± 10.293	0.475	0.702
Left lateral flexion (°)	35.00 ± 9.129	28.90 ± 5.744	27.30 ± 9.922	33.14 ± 8.896	1.704	0.185
Right lateral flexion (°)	41.40 ± 8.435	36.70 ± 9.487	30.20 ± 7.829	36.86 ± 10.653	2.607	0.068
Left rotation (°)	74.30 ± 10.822	64.90 ± 14.027	69.20 ± 18.128	73.71 ± 15.381	0.833	0.485
Right rotation (°)	78.10 ± 11.666	78.80 ± 12.200	70.10 ± 16.162	75.14 ± 13.753	0.852	0.475

Within-group changes

Following the 8-week intervention, paired t-tests were conducted to evaluate within-group changes. As shown in Table 2, Group A (elastic band) showed significant improvements in the NDI, FHA and FSA, vital capacity, and all CROM directions except left rotation ($p<0.050$).

The VAS for Group A approached but did not reach statistical significance (p=0.052). Group B statistically demonstrated significant improvements in NDI, FHA, vital capacity, cervical extension, and bilateral lateral flexion (p<0.050). However, changes in VAS, FSA, cervical flexion, and bilateral rotation for Group B were not statistically significant (p > 0.050). Group C exhibited significant improvements across almost all key measured parameters, including VAS, NDI, FHA, FSA, vital capacity, and most CROM directions (p<0.050), with the exception of cervical left rotation (p=0.099).

Table 2. Within-group comparisons of outcome measures before and after the 8-week intervention.

Parameters	Group A (n=10)			Group B (n=10)			Group C (n=10)		
	Pre	Post	p-value	Pre	Post	p-value	Pre	Post	p-value
Subjective questionnaires									
VAS (score)	3.80 ± 2.25	2.30 ± 1.34	0.052	4.80 ± 2.62	3.20 ± 1.69	0.161	4.40 ± 2.72	2.30 ± 1.49	0.002
NDI (%)	19.80 ± 14.68	8.60 ± 2.50	0.029	18.00 ± 11.62	13.40 ± 3.53	0.006	16.20 ± 10.43	9.60 ± 6.85	0.001
Postural assessment									
FHA (°)	29.60 ± 7.07	26.90 ± 5.45	0.006	33.90 ± 6.33	31.00 ± 6.80	0.041	34.70 ± 6.22	31.90 ± 5.99	0.013
FSA (°)	30.30 ± 7.92	27.30 ± 7.17	0.005	30.30 ± 7.82	28.60 ± 4.09	0.553	33.10 ± 5.41	28.20 ± 4.85	0.016
Pulmonary function									
Vital capacity (mL)	3170.90 ± 709.95	3692.30 ± 681.77	0.004	2389.50 ± 296.90	2902.60 ± 443.07	0.001	2730.40 ± 596.07	3413.20 ± 541.94	0.001
Cervical range of motion									
Forward flexion (°)	36.50 ± 9.14	58.40 ± 13.85	0.002	37.20 ± 12.63	47.70 ± 10.52	0.052	35.30 ± 12.60	50.00 ± 14.67	0.011
Extension (°)	38.50 ± 8.40	64.00 ± 13.83	0.000	38.10 ± 7.98	64.70 ± 14.95	0.001	37.50 ± 9.50	67.10 ± 14.21	0.000
Left lateral flexion (°)	35.00 ± 9.13	49.40 ± 8.73	0.008	28.90 ± 5.74	41.20 ± 8.39	0.002	27.30 ± 9.92	41.10 ± 10.30	0.003
Right lateral flexion (°)	41.40 ± 8.44	58.90 ± 13.34	0.003	36.70 ± 9.49	48.00 ± 4.90	0.003	27.80 ± 10.83	49.20 ± 12.52	0.000
Left rotation (°)	74.30 ± 10.82	80.40 ± 8.36	0.156	64.90 ± 14.03	72.00 ± 10.89	0.085	69.20 ± 18.13	76.60 ± 10.56	0.099
Right rotation (°)	78.10 ± 11.67	85.60 ± 6.00	0.009	78.80 ± 12.20	78.10 ± 14.04	0.648	70.10 ± 16.16	81.00 ± 10.21	0.024

Between-group comparisons at post-intervention

Following the 8-week intervention, post-hoc analyses were performed to compare the outcomes among the four groups. As shown in Table 3, compared with the control group (Group H), Group A demonstrated significant superiority in the NDI, (FSA, vital capacity, and cervical ranges of motion including forward flexion, extension, and bilateral lateral flexion (all p<0.050). Group B showed significant differences only in cervical extension and right lateral flexion when compared to Group H (p<0.050). Group C exhibited significant improvements over Group H in NDI, cervical extension, and bilateral lateral flexion (all p<0.050). Furthermore, comparisons among the three intervention groups revealed that Group A yielded significantly better outcomes than Group B in NDI, vital capacity, and bilateral lateral flexion of the cervical spine (all p<0.050). These results indicate that while all three interventions provided certain benefits, the elastic band resistance training (Group A) was the most effective approach for correcting UCS and improving related physical functions.

Table 3. Between-group comparisons of post-intervention outcomes.

Parameters	Group A (n=10)	Group B (n=10)	Group C (n=10)	Group H (n=7)
Subjective questionnaires				
VAS (score)	2.30 ± 1.34	3.20 ± 1.69	2.30 ± 1.49	3.71 ± 1.38
NDI (%)	8.60 ± 2.50*#	13.40 ± 3.53	9.60 ± 6.85*	18.86 ± 8.47
Postural assessment				
FHA (°)	26.90 ± 5.45	31.00 ± 6.80	31.90 ± 5.99	33.71 ± 6.40
FSA (°)	27.30 ± 7.17*	28.60 ± 4.09	28.20 ± 4.85	33.86 ± 4.14
Pulmonary function				
Vital capacity (mL)	3692.30 ± 681.77*#	2902.60 ± 443.07	3413.20 ± 541.94	2804.00 ± 322.06
Cervical range of motion				
Forward flexion (°)	58.40 ± 13.85*	47.70 ± 10.52	50.00 ± 14.67	39.86 ± 7.11
Extension (°)	64.00 ± 13.83*	64.70 ± 14.95*	67.10 ± 14.21*	40.86 ± 11.02
Left lateral flexion (°)	49.40 ± 8.73*#	41.20 ± 8.39	41.10 ± 10.30*	31.57 ± 4.96
Right lateral flexion (°)	58.90 ± 13.34*#	48.00 ± 4.90*	49.20 ± 12.52*	35.71 ± 9.12
Left rotation (°)	80.40 ± 8.36	72.00 ± 10.89	76.60 ± 10.56	72.29 ± 15.07
Right rotation (°)	85.60 ± 6.00	78.10 ± 14.04	81.00 ± 10.21	75.29 ± 13.73

Data are expressed as mean ± standard deviation. * indicates a statistically significant difference compared to the control group (Group H), $p<0.050$. # indicates a statistically significant difference compared to the verbal cueing group (Group B), $p<0.050$.

Discussion

Summary of main findings

This study aimed to explore the effects of different interventions on female college students with characteristics of UCS. The results indicated that all three methods: elastic band resistance training, verbal cueing, and combined intervention had positive effects on alleviating pain, correcting poor posture, and improving cervical range of motion caused by UCS. However, between-group comparisons revealed that the isolated elastic band resistance training (Group A) demonstrated the most optimal intervention efficacy in improving the NDI, FSA, vital capacity, and multiple directions of cervical range of motion. This core finding is highly consistent with recent literature. For instance, Chaudhuri et al. explicitly stated in a systematic review and meta-analysis that exercise therapy provides significant benefits in correcting postural alignment and improving functional limitations in patients with UCS. Furthermore, a randomized controlled trial by Yaghoubitajani et al. confirmed that an 8-week corrective strength exercise program significantly improved forward head posture, rounded shoulders, and neck-shoulder pain, which perfectly aligns with the positive outcomes achieved by Group A and Group C after the 8-week intervention in our study [6]. Although the verbal cueing method (Group B) also showed improvements in certain parameters, its overall effectiveness was inferior to that of the elastic band intervention, further highlighting the central role of targeted muscle resistance training in correcting UCS.

Physiological mechanisms of elastic band intervention

The superior efficacy of elastic band resistance training (Group A) in improving UCS can be deeply explained by the theories of muscle imbalance and reciprocal inhibition. According to Chang et al., UCS is fundamentally a neuromuscular dysfunction characterized by a predictable pattern of muscle imbalance, where the anterior pectoral muscles and upper trapezius become adaptively shortened and hypertonic, while their antagonists, such as the deep cervical flexors, lower trapezius, and rhomboids, become lengthened and weak [7]. The elastic band intervention effectively interrupts this pathological cycle. By utilizing the progressive resistance of the elastic band, the training protocol not only mechanically stretches the tight muscles but also precisely targets and strengthens the weakened stabilizers. This targeted strengthening induces reciprocal inhibition, a neural mechanism where the activation of the agonist muscle leads to the simultaneous neurological relaxation of the overactive antagonist muscle [8]. Consequently, as the strength of the middle and lower trapezius increases, the pathological tension in the upper trapezius and pectoral muscles is naturally downregulated. This biomechanical restoration of the shoulder-neck tension balance directly relieves the abnormal mechanical pressure on the cervical spine, which explains the significant reduction in the NDI and the CROM observed in Group A and Group C.

The role and limitations of verbal cueing

The present study found that verbal cueing (Group B) produced statistically significant improvements in certain parameters, such as the NDI and cervical extension. This positive outcome can be attributed to the enhancement of postural awareness. As highlighted by Bhandary et al., interventions focused on postural awareness can effectively interrupt prolonged abnormal postures by consciously recalibrating proprioceptive feedback, which provides immediate and short-term relief from cervical mechanical stress. By reminding participants to self-correct their posture, verbal cueing facilitates the conscious activation of the neuromuscular system.

However, the results also clearly demonstrated that verbal cueing alone is insufficient for achieving comprehensive structural correction, particularly regarding the FSA and multiple directions of cervical range of motion. The primary limitation of this cognitive approach lies in its inability to provide sufficient mechanical overload. Gumuscu et al. noted that while awareness and biofeedback techniques are valuable adjuncts, they do not induce the morphological adaptations, such as muscle hypertrophy or the lengthening of adaptively shortened fascial tissues, required to reverse chronic UCS [9]. A 30-second isometric hold prompted by a verbal cue lacks the progressive resistance necessary to remodel the weakened rhomboids and lower trapezius. This physiological bottleneck also explains why the Group C did not yield a strictly additive effect when compared to the Group A. Once the mechanical threshold for muscle remodeling is met through resistance training, the additional cognitive prompts offer limited structural benefits.

Connection between UCS posture and pulmonary function

Another significant finding of this study is that the interventions not only improved musculoskeletal symptoms but also significantly increased the vital capacity of the participants. This result extends the impact of UCS from a purely postural issue to the level of visceral respiratory function. Studies have shown that efficient breathing highly depends on adequate thoracic expansion and coordinated diaphragmatic movement. Abnormal postures such as forward head and rounded shoulders, however, severely disrupt the biomechanics of the rib cage [10]. In patients with UCS, the excessively tight pectoralis minor and major limit the upward and outward movement of the ribs, while increased thoracic kyphosis compresses the thoracic volume, forcing the body to over-rely on accessory respiratory muscles and consequently leading to a decrease in vital capacity.

Following the 8-week elastic band and combined interventions, the FSA and FHA of the participants were significantly corrected. The restoration of posture directly relieved the mechanical restriction on the thorax. This is corroborated by the study of Guo et al., who found that targeted posture-correcting exercises effectively improved chest expansion and peak expiratory flow in individuals with UCS [11]. In our study, the significant increase in vital capacity in the Group A was precisely due to the strengthened rhomboids and middle-to-lower trapezius, which facilitated scapular retraction and allowed the thoracic cavity to expand again, thereby providing sufficient space for diaphragmatic excursion. This also offers a highly promising non-pharmacological treatment perspective for improving chronic respiratory restriction through exercise rehabilitation in clinical practice.

Limitations and future directions

While this study provides valuable insights into the management of UCS, several limitations must be acknowledged. First, the sample size was relatively small (n=37) and restricted exclusively to female university students. As Sepehri et al. highlighted in their recent meta-analysis, the biomechanical characteristics and responsiveness to corrective exercises may vary significantly across different age groups, genders, and occupational backgrounds [12]. Therefore, the generalizability of our findings to the broader population remains limited. Second, the 8-week intervention period, although sufficient to induce initial morphological and functional improvements, lacked a long-term follow-up phase. The durability of the corrected postural alignment and the potential recurrence rate of UCS symptoms after the cessation of the exercise programs remain unclear. Finally, the outcome measures predominantly relied on surface postural assessments and subjective questionnaires. Although these are clinically relevant, they do not directly quantify internal neuromuscular changes. Bayattork et al. emphasized the critical importance of utilizing surface electromyography to accurately evaluate the activation ratios of scapulothoracic muscles during UCS rehabilitation [13].

Future research should aim to conduct large-scale, multi-center randomized controlled trials with more diverse demographic populations. Furthermore, incorporating extended follow-up periods and utilizing objective neurophysiological assessment tools, such as sEMG or musculoskeletal ultrasound, will be essential to deeply elucidate the long-term neuromuscular remodeling mechanisms of these interventions.

Conclusion

In conclusion, this 8-week randomized controlled trial demonstrates that while elastic band resistance training, verbal cueing, and their combination all provide therapeutic benefits for female college students with UCS, the isolated elastic band intervention is the most effective approach. It not only significantly corrects postural deviations, such as forward head and rounded shoulders, and increases cervical range of motion, but also effectively improves vital capacity by alleviating mechanical restrictions on the thorax. Although verbal cueing enhances postural awareness, it lacks the necessary mechanical resistance to induce structural neuromuscular remodeling. Therefore, progressive elastic band resistance training is highly recommended as a primary, cost-effective, and easily implementable non-pharmacological strategy in the clinical and daily management of UCS and its associated respiratory limitations.

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Conflict of Interest

The authors declare no conflict of interest.

References

[1] Nemati, M., Saki, F., Ramezani, F. (2025) Adding respiratory exercises to scapular stabilization training in adolescent girls with upper cross syndrome: a randomized controlled trial. *BMC Sports Science, Medicine and Rehabilitation*, 17(1), 1-12.

[2] Zhang, C., Zhang, J., Yang, G. (2023) Association between internet addiction and the risk of upper cross syndrome in Chinese college students: a cross sectional study. *Medicine*, 102(30), e34273.

[3] Ahmed, S., Mishra, A., Akter, R., Shah, M. H., Sadia, A. A. (2022) Smartphone addiction and its impact on musculoskeletal pain in neck, shoulder, elbow, and hand among college going students: a cross-sectional study. *Bulletin of Faculty of Physical Therapy*, 27(1), 5.

[4] Azam, H., Fatima, N., Asjad, A., Ashraf, I., Asif, T., Rehman, F. (2022) Comparative effects of comprehensive corrective exercises versus muscle energy techniques in patients with upper cross syndrome: a randomized controlled trial: corrective exercises vs muscle energy techniques in patients with upper cross syndrome. *Pakistan BioMedical Journal*, 173-177.

[5] Bhandary, V., Premkumar, M., Sequeira, S. E. (2025) Comparative effectiveness of posture correction exercises versus postural awareness on forward head posture, protruded shoulder and thoracic kyphosis in 13-15 year old smartphone users: a randomized controlled trial intervention protocol. *International Journal of Clinical Trials*, 12(3), 215.

[6] Yaghoubitajani, Z., Gheitasi, M., Bayattork, M., Andersen, L. L. (2022) Corrective exercises administered online vs at the workplace for pain

and function in the office workers with Upper Crossed Syndrome: randomized controlled trial. *International Archives of Occupational and Environmental Health*, 95(8), 1703-1718.

[7] Chang, M. C., Choo, Y. J., Hong, K., Boudier-Reveret, M., Yang, S. (2023) Treatment of Upper Crossed Syndrome: a narrative systematic review. *Healthcare*, 11(16), 2328.

[8] Gera, C., Lamba, S., Pawalia, A., Panihar, U. (2023) Efficacy of various exercises in the management of Upper Crossed Syndrome. *Comparative Exercise Physiology*, 19(3), 207-214.

[9] Gumuscu, B. H., Kisa, E. P., Kaya, B. K., Muammer, R. (2023) Comparison of three different exercise trainings in patients with chronic neck pain: a randomized controlled study. *The Korean Journal of Pain*, 36(2), 242-252.

[10] Liu, H., Wiedman, C. M., Lovelace-Chandler, V., Gong, S., Salem, Y. (2024) Deep diaphragmatic breathing - anatomical and biomechanical consideration. *Journal of Holistic Nursing*, 42(1), 90-103.

[11] Guo, Y., Li, M., Xie, C., Liu, X., Chen, Y., Yang, J., Wu, Y., Chen, S., Wang, S., Lin, J. (2025) Effect of the cervical and thoracic “Daoyin” training on posture and pulmonary function in patients with Upper Crossed Syndrome: A randomized controlled trial. *BMC Complementary Medicine and Therapies*, 25(1), 41.

[12] Sepehri, S., Sheikhhoseini, R., Piri, H., Sayyadi, P. (2024) The effect of various therapeutic exercises on forward head posture, rounded shoulder, and hyperkyphosis among people with Upper Crossed Syndrome: a systematic review and meta-analysis. *BMC Musculoskeletal Disorders*, 25(1), 105.

[13] Bayattork, M., Seidi, F., Yaghoubitajani, Z., Andersen, L. L. (2024) Electromyographic comparison of exercises for scapulothoracic muscle activation in men with Upper Crossed Syndrome: a cross-sectional study. *Journal of Bodywork and Movement Therapies*, 40, 1679-1685.