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Effect of 8 Weeks of Ergonomics Education and Corrective Exercises on Upper Crossed Syndrome in Men

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Abstract

Background: Upper Cross Syndrome (UCS) is a common musculoskeletal condition characterized by forward head posture, rounded shoulders, and an increased kyphosis angle. UCS can lead to pain, discomfort, and impaired function.

Aim: This investigation aimed to study the impact of 8 weeks of ergonomics education and corrective exercises on UCS in men aged 18-30.

Materials and Methods: This quasi-experimental study was conducted on men aged 18–30 years with upper crossed syndrome (UCS) in Quchan. Forty-eight participants were randomly assigned to three groups ($n = 16$ each): a corrective exercise group, an ergonomic intervention group, and a control group. The intervention groups underwent 60-minute sessions, three times a week, for eight weeks. Postural angles—forward head, forward shoulder, and thoracic kyphosis—were measured using a flexible ruler (IDIO brand) and a digital camera. Data were analyzed using Repeated Measures ANOVA and Bonferroni post hoc tests in SPSS version 22, with a significance level of $\alpha < 0.05$.

Results: Following the interventions, the corrective exercise group demonstrated greater improvements in all postural measures compared to the ergonomic and control groups. Specifically, forward head angle improved significantly ($p < 0.001$, $\eta^2 = 0.605$), with a mean reduction of 7.98° compared to the control group. Similarly, kyphosis angle decreased significantly ($p < 0.001$, $\eta^2 = 0.552$), showing a 7.19° improvement over the control. Additionally, the rounded shoulder angle improved significantly compared to the ergonomic group ($p < 0.001$, $\eta^2 = 0.401$), but not compared to the control group ($p = 1.000$). In contrast, the ergonomic group showed moderate improvements in kyphosis ($p = 0.007$) and rounded shoulders ($p < 0.001$) compared to the control group, but no significant change in forward head posture ($p = 0.067$).

Conclusion: Corrective exercises were more effective than ergonomic interventions or no treatment in improving postural abnormalities associated with upper crossed syndrome. Specifically, these exercises resulted in significant reductions in forward head, kyphosis, and rounded shoulder angles, underscoring their clinical value for posture correction in young men.

Keywords: Upper Cross Syndrome, ergonomics, corrective exercises, posture, men

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1. Introduction

Upper Crossed Syndrome (UCS) is a common postural disorder characterized by muscular imbalances in the head, neck, shoulders, and upper thoracic regions, often resulting from prolonged sedentary behavior or improper ergonomics at work (1). This condition typically results in forward head posture, rounded shoulders, and thoracic kyphosis, leading to neck and upper back pain, limited mobility, and potential long-term disability if left uncorrected (2, 3). Muscle imbalances in UCS are characterized by overactive and tight upper trapezius, levator scapulae, and pectoral muscles, while the deep neck flexors and lower scapular stabilizers become lengthened and weak (1). These imbalances disrupt normal joint alignment and movement patterns, placing additional stress on soft tissues and spinal structures.

UCS is especially common among professionals who spend long periods sitting at desks or performing repetitive upper extremity tasks (4), with reported prevalence rates ranging from 27% among physiotherapists (5) to 45% among physical therapy students (6). These numbers highlight the need for preventive and rehabilitative approaches.

Treatment of UCS typically includes corrective exercises targeting muscle length and strength imbalances. Ergonomic education helps change harmful postures and behaviors (2, 7). Physical modalities, such as manual therapy, heat, and stretching, are often used in conjunction with exercises.

Ergonomics, as defined by the International Ergonomics Association, is the science of optimizing human interaction with systems and environments and has been shown to reduce work-related musculoskeletal disorders (7). Modern reliance on computers and smartphones increases poor postural habits, significantly contributing to UCS (8). Prior research has shown that ergonomic interventions improve postural alignment and reduce pain (9).

Few studies have evaluated the combined effect of ergonomic education and corrective exercises in male office workers or laborers. Although occupational exposures and movement patterns differ by gender (10), research specifically examining men is limited. The impact of these programs on men remains unclear, marking a gap in the literature.

Research by Karimian et al. (2019) and Mohammadi Zeydi et al. (2010) finds that combining corrective exercises, such as those from the National Academy of Sports Medicine (NASM), with ergonomics education improves postural metrics and reduces musculoskeletal complaints (11, 12). Ketola et al. (2002) also showed long-term reductions in discomfort through comprehensive ergonomic programs (13).

Postural education and correction strategies aim to modify habitual movement patterns, including those at work and in daily life, such as sitting, standing, and device use. These strategies can improve body awareness and prevent postural deterioration (14-18). Correct posture education is crucial for maintaining health and preventing injuries.

This study aims to determine whether eight weeks of combined ergonomics education and corrective exercises improve postural deviations associated with UCS in young men. By directly addressing the limited research on male populations and providing targeted interventions, the study intends to generate actionable recommendations for clinicians and occupational health professionals.

2. Methods and Materials

2.1. Participation

The Human Ethics Research Committee of the Sport Sciences Research Institute of Iran approved this study. The study complied with the Ethical Standards in Research of the Ministry of Science, Research, and Technology, as outlined in code IR.SSRC.REC.1403.071. All procedures are also followed by the Declaration of Helsinki. This research used a quasi-experimental design. The statistical population consisted of men aged 18–30 years with UCS in Quchan.

The required sample size was determined using G*Power 3.1. The test family was set to F tests, and the selected statistical test was ANOVA: Repeated measures, within–between interaction, corresponding to the design of the present study. A medium effect size of f = 0.50 was chosen based on previous research on postural intervention outcomes. The Type I error probability (α) was set at 0.05, and the desired statistical power was set at 0.95. The number of groups was defined as three, and the number of measurements as three, assuming a correlation of 0.5 among repeated measures and a nonsphericity correction ε of 1.0. According to the G*Power output, the minimum total sample size required to detect a within–between interaction effect with 95% statistical power was 48 participants. Initially, 121 men volunteered for posture screening at a sports club using posture grids, and 54 of them met the preliminary criteria for potential Upper Crossed Syndrome (UCS).

Their thoracic kyphosis, forward head posture, and forward shoulder posture were measured to confirm eligibility. Based on inclusion and exclusion criteria, 48 individuals who showed all three postural abnormalities were selected for the study.

Participants were randomly assigned to one of three groups (n = 16 per group) using a computer-generated random number table in Microsoft Excel. The corrective exercise group received a program that focused on structured physical exercises designed to correct posture and movement patterns. The ergonomic intervention group received personalized guidance and workstation modifications designed to improve work-related ergonomics. The control group received no intervention and continued their usual work and daily activities. Outcome assessors were blinded to group allocation to minimize bias.

Participants performed exercises for 60 minutes per session, three times a week, over an eight-week period. The schedule and intervention details are outlined in the Consort flow chart for enrollment and intervention (Fig. 1). Before starting, each subject received a comprehensive written description of the research process. Written informed consent was obtained from all participants.

Only male participants were included in the study to control for gender-related physiological and biomechanical differences, ensuring sample homogeneity.

Inclusion and Exclusion Criteria

Inclusion criteria were an age range of 18 to 30 years, a diagnosis of UCS (posterior kyphosis greater than 42 degrees, forward head posture greater than 45 degrees, and forward shoulder posture greater than 52 degrees (11), the absence of any pathological symptoms such as a history of fracture, surgery, and spinal diseases (11), absence of lumbar hyperlordosis, a non-obese body mass index (BMI < 25 kg/m²), and no history of athleticism or regular physical activity (i.e., <2 structured sessions per week over the past 6 months).

Exclusion criteria applied to participants who met inclusion criteria but were later disqualified due to the emergence or identification of the following conditions: any pathological symptoms (e.g., history of spinal surgery, fracture, or disease), engagement in regular physical activity during the intervention period, or failure to comply with study procedures.

2.2. Instrument

The tools and instruments used for data collection included an IDIO brand flexible ruler (50 cm in length and 2 cm in width, manufactured in Thailand) for measuring thoracic kyphosis (19), and a digital camera for capturing posture-related anatomical landmarks.

The thoracic kyphosis angle was measured using a flexible ruler. The flexicurve method was applied by placing the ruler along the subject's spine between the spinous processes of T2 and T12. The contour of the spine was then traced onto graph paper, and the kyphosis angle was calculated using standard geometric formulas. This method has been validated in previous studies and demonstrates high reliability, with intraclass correlation coefficients (ICC = 0.92) reported in the literature (20).

Forward head angle (FHA) and rounded shoulder angle (RSA) were assessed using photographic analysis based on anatomical landmarks, including the tragus of the ear, the spinous process of C7, and the acromion. This method has been validated in previous research, demonstrating excellent reliability with intraclass correlation coefficients (ICCs) of 0.92 for FHA and 0.89 for RSA, and standard error of measurement (SEM) values of approximately 2° and 5°, respectively (21).

2.3. Procedure

Measurement of the kyphosis

The Corrective Exercise Specialist conducted the measurements. The thoracic kyphosis angle was measured using a flexicurve ruler, 50 cm long and 2 cm wide. The starting and ending points for the measurement were the spinous processes of the T2 and T12 vertebrae(19, 20). To locate the spinous process of the T2 vertebra, the examiner positioned themselves behind the subject and instructed them to bend their head. This positioning revealed two prominences at the base of the cervical region, representing the spinous processes of the C6 and C7 vertebrae. The examiner then asked the subject to slowly tilt their head backward by applying slight pressure to these prominences. During this movement, one of the prominences (C6) no longer remained palpable, leaving only the single prominence of the C7 vertebra. By identifying the C7 spinous process, it became easier to locate the spinous processes of the T1 and T2 vertebrae by gently tracing down the spine. In the current study, after identifying the T2 vertebra, the starting point of the kyphosis curve was marked using a landmark. To determine the T12 vertebra, researchers utilized the widely accepted Hoppenfeld method in numerous studies (22). Individuals with a kyphotic angle greater than 42 degrees were classified as having an increased kyphotic deformity.

Measurement of the forward head and rounded shoulder angles

Forward head angle (FHA) and rounded shoulder angle (RSA) were assessed using photogrammetry with lateral-view digital photography. FHA was defined as the angle between a vertical reference line and a line connecting the tragus and the C7 marker. Based on established criteria, an FHA of less than 36° indicates normal alignment, whereas values greater than 45° represent forward head posture(11, 23). RSA was defined as the angle between a vertical posterior reference line and a line connecting the C7 and acromial markers (24), with angles greater than 52° indicating rounded shoulder deformity(11, 23).

Anatomical landmarks including the tragus, C7, and acromion were identified and marked using non-erasable markers. Participants stood 23 cm from a wall with their left arm positioned adjacent to it. A Xiaomi 13 Pro digital camera was mounted on a tripod placed 265 cm from the participant, with the height adjusted to the level of the participant's right shoulder to ensure a horizontal line of sight.

To achieve a natural standing posture, participants were asked to bend forward three times and raise their arms overhead three times before standing comfortably and gazing at a fixed point at eye level. After a 5-second pause, a lateral photograph was captured. Images were transferred to a computer and analyzed using AutoCAD software. FHA was calculated as the angle between the tragus–C7 line and a vertical line, and RSA was calculated as the angle between the C7–acromion line and a vertical line. Three images were taken for each participant, and the mean of the three measurements was used as the final FHA and RSA value (25).

Previous photogrammetric studies have reported acceptable within-day reliability for FHA and RSA, with intraclass correlation coefficients typically ranging from $ICC_{(2,1)} = 0.89$ to 0.92, and standard errors of measurement of approximately 2° for FHA and 5° for RSA (26). In the present study, intra- and inter-rater reliability were not assessed; therefore, the reliability values cited above are based on previously published literature rather than being calculated from the current dataset.

Corrective Exercises along with Ergonomics Education

Ergonomics Education

The sessions were held in person at the gym and were conducted by a corrective exercise specialist. The educational content of the sessions was prepared based on information available in books, articles, and expert interpretations in the field of computer ergonomics. The content of the educational sessions included basic definitions of ergonomics, risk factors for musculoskeletal disorders, the effects of computer work and methods of preventing them, correct posture when working with a computer, how to adjust the screen and keyboard and their appropriate distance, the location and appropriate size of the mouse, the appropriate seat height, seat characteristics, and appropriate sitting position (27).

Educational delivery methods included a combination of lectures with PowerPoint presentations, group discussions, practical demonstrations, and printed handouts provided to participants. During each session, participants were encouraged to ask questions and actively engage in correcting their sitting posture under the guidance of the instructor. The entire educational course consisted of four one-hour sessions held every other week (28, 29), which reflects the typical structure of ergonomics education programs that focus on knowledge transfer and workstation modification rather than repeated physical training. However, this shorter total exposure time compared to the corrective exercise program may have resulted in less direct supervised engagement, which should be considered when interpreting group differences.

To ensure adherence and fidelity to the educational intervention, attendance was recorded for each session, and participants were given brief homework tasks (e.g., adjusting their workstation and taking posture-awareness notes), which were reviewed in subsequent sessions.

Additionally, a supplementary table at the end of the manuscript provides a summary of the ergonomics education content and implementation tips (Table 1).

Corrective Exercises

The 8-week corrective exercise program was conducted in a gym setting under the supervision of a certified corrective exercise specialist. Designed according to the National Academy of Sports Medicine (NASM) guidelines and refined with input from physiotherapy experts, the program targets postural abnormalities associated with Upper Crossed Syndrome (UCS) through structured stretching and strengthening routines(11). Each session began with a 5–to 10-minute general warm-up, followed by progressively more challenging exercises. In weeks 1–2, the focus was on stretching overactive muscles (e.g., pectoralis major/minor, upper trapezius) and activating underactive ones (e.g., deep neck flexors, lower trapezius) using two sets of 10 reps. Weeks 3–5 increased intensities to 3 sets of 12 reps, enhancing neuromuscular control. During weeks 6–8, the program focused on endurance and postural stability, incorporating three sets of 15 repetitions and gradually increasing resistance. All sessions were closely supervised to ensure correct technique, participant safety, and training effectiveness (Table 2).

2.4. Statistic

In this study, descriptive statistics (mean and standard deviation) and inferential analyses were used. Data normality was checked using the Shapiro-Wilk test**,** and variance homogeneity with Levene's test**.** For hypothesis testing, Repeated Measures ANOVA and Bonferroni post hoc test were applied using SPSS v22, with a significance level of $p < 0.05$**.**

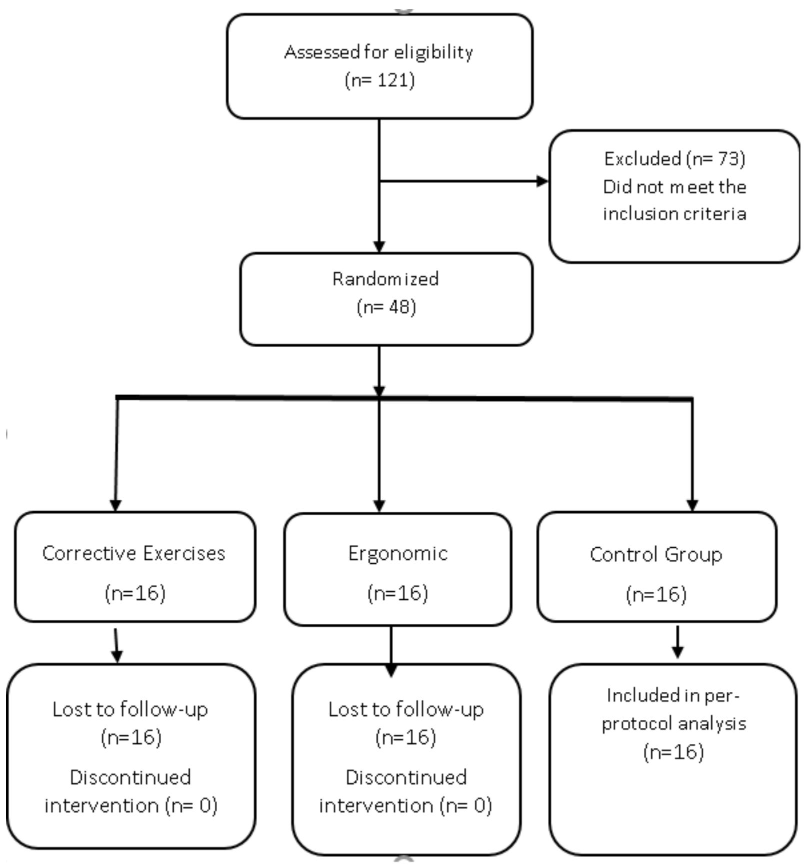

Figure 1. CONSORT flow diagram of participant enrollment, allocation, intervention, follow-up, and analysis

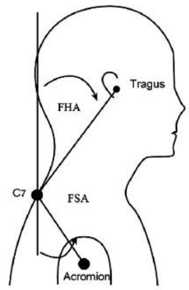

Figure 2. FHA measured from the vertical anteriorly to a line connecting the tragus and the C7 marker. The forward shoulder angle (RSA) was measured by determining the angle between a vertical line running posteriorly and the line connecting the markers at the C7 and acromial positions(24).

Table 1. Summary of Ergonomics Education Content and Implementation Tips

Topic	Content Summary	Implementation Tips
Basic Definitions of Ergonomics	Definition and importance of ergonomics in daily and workplace settings	Presented with simple, real-life examples
Risk Factors for MSDs	Common causes of musculoskeletal disorders (MSDs) due to poor posture and prolonged sitting	Visual comparison of correct vs. incorrect postures
Effects of Computer Work	Postural strain, muscle fatigue, discomfort, and injury caused by improper workstation setup	Simulated typical work conditions and analysis
Monitor and Keyboard Adjustment	Optimal distance, height, and angle of the screen and keyboard	Participants practiced adjusting their own setups
Mouse Placement and Size	Ideal position, shape, and ergonomic design of the mouse	Demonstration and comparison of mouse types
Ergonomic Chair Characteristics	Proper height, back support, lumbar support, and seat material	Demonstrated ergonomic vs. non-ergonomic chairs
Correct Sitting Posture	Alignment of ears, shoulders, and hips; feet flat on floor; 90-degree angles at knees and elbows	Real-time feedback during mirror-based posture correction practice
Practical Application	Workplace posture corrections, personal habit evaluation	Homework: review and adjust personal workstation, take posture-awareness notes
Educational Tools	PowerPoint presentations, handouts, group discussions, live demonstrations	Printed materials distributed; encouraged active note-taking
Participant Engagement	Q&A, attendance tracking, review of tasks	Short homework assignments to reinforce learning (e.g., adjust desk, observe posture daily)

Table 2. 8-Week NASM-Based Corrective Exercise Program for Upper Crossed Syndrome

Week	Warm-Up	Inhibitory Techniques	Lengthening Techniques	Activation Techniques	Integration Techniques
1-2	5–10 min general aerobic warm-up	SMR: Upper trapezius, levator scapulae (30s/side)	Static stretching: Pectoralis major/minor, upper trapezius (30s x 2 sets)	Chin tucks, Scapular retraction with resistance band (2 sets of 10 reps)	Wall slides, Standing posture holds (2 sets of 10 reps)
3-5	5–10 min dynamic warm-up	SMR: Pecs, SCM, Upper traps (30s/side)	Static stretching: SCM, Pecs, UT (30s x 2 sets)	Prone Y-T-W holds, Theraband rows (3 sets of 12 reps)	Wall angels, Standing posture drills (3 sets of 12 reps)
6-8	5–10 min dynamic warm-up with posture cues	SMR: Pec minor, UT, SCM (30s/side)	Static stretching: All target muscles (30s x 2–3 sets)	Isometric chin tucks, Scapular clocks (3 sets of 15 reps)	Resisted band pull-aparts, Posture reinforcement holds (3 sets of 15 reps)

3. Results

The one-way ANOVA showed no statistically significant differences in demographic variables among the three groups. Specifically, there were no significant differences in age ($F = 2.272$, $p = 0.115$), height ($F = 0.268$, $p = 0.766$), or weight ($F = 0.004$, $p = 0.996$) between the corrective exercises, ergonomic, and control groups. These results indicate group homogeneity at baseline for basic characteristics (Table 3).

The Shapiro-Wilk test confirmed that all pre-test variables were normally distributed in the three groups ($p > 0.05$), supporting the use of parametric tests (Table 4). Levene's test ($p > 0.05$) confirmed homogeneity of variances. The regression slope test showed that the regression slope was homogeneous.

Repeated measures ANOVA revealed that both corrective exercises and ergonomic interventions significantly improved all three postural variables, whereas the control group showed no improvement or deterioration. For the forward head angle, time ($p < 0.001$, $\eta^2 = 0.301$), group ($p < 0.001$, $\eta^2 = 0.605$), and interaction ($p < 0.001$, $\eta^2 = 0.413$) effects were all statistically significant, indicating changes over time varied by intervention. For kyphosis, significant effects were seen for time ($p = 0.013$, $\eta^2 = 0.136$), group ($p < 0.001$, $\eta^2 = 0.552$), and the time × group interaction ($p = 0.025$, $\eta^2 = 0.158$). For the rounded shoulder angle, all effects were significant ($p < 0.001$; $\eta^2 = 0.298$ for time, $\eta^2 = 0.401$ for group, and $\eta^2 = 0.306$ for interaction). These results suggest that the type of intervention was key to postural improvement. Bonferroni post hoc tests were used to determine which intervention had the most significant effect on each variable (Table 5).

Table 3: Comparison of Demographic Variables Between Intervention and Control Groups Using One-Way ANOVA

Variable	Number	Corrective Exercises (Mean ± SD)	Ergonomic (Mean ± SD)	Control (Mean ± SD)	One- Way ANOVA Test F	P-value
Age (years)	16	24.6 ± 4.13	22.20 ± 2.20	23.80 ± 3.80	2.272	0.115
Height (cm)	16	175.20 ± 5.29	172.70 ± 7.31	174.20 ± 5.32	0.268	0.766
Weight (kg)	16	71.66 ± 5.14	72.20 ± 6.92	71.66 ± 6.36	0.004	0.996

Table 4. Results of the Shapiro-Wilk Test for Normality of Pre-Test Postural Angles Across Study Groups

Variable	Group	Statistic	df	Sig.
Forward Head Angle (Pre)	CE	0.926	16	0.211
	Ergonomic	0.930	16	0.274
	Control	0.938	16	0.360
Kyphosis Angle (Pre)	CE	0.932	16	0.265
	Ergonomic	0.899	16	0.091
	Control	0.935	16	0.327
Forward Shoulder Angle (Pre)	CE	0.922	16	0.180
	Ergonomic	0.939	16	0.371
	Control	0.928	16	0.256

CE: Corrective Exercises

Repeated measures ANOVA showed that both corrective exercises and ergonomic interventions led to improvements in postural variables; however, the pattern and statistical significance of these changes differed between groups. The corrective exercise group demonstrated significant improvements in all three postural measures (forward head posture, thoracic kyphosis, and rounded shoulder angle), whereas the ergonomic intervention produced significant improvements only in thoracic kyphosis and rounded shoulder angles, with no significant change observed in forward head posture ($p = 0.067$). Prior to conducting the analyses, Mauchly's test of sphericity was performed to assess the assumption of sphericity. The results indicated that the assumption of sphericity was not violated for any of the variables ($W > 0.75$, $p > 0.05$).

Significant effects were found for all three postural variables. For the forward head angle, there were significant effects of time ($F(1,45) = 19.38$, $p < 0.001$, partial $\eta^2 = 0.301$), group ($F(2,45) = 34.46$, $p < 0.001$, partial $\eta^2 = 0.605$), and time × group interaction ($F(2,45) = 15.83$, $p < 0.001$, partial $\eta^2 = 0.413$). Similarly, for kyphosis, significant effects were observed for time ($F(1,45) = 7.08$, $p = 0.013$, partial $\eta^2 = 0.136$), group ($F(2,45) = 27.72$, $p < 0.001$, partial $\eta^2 = 0.552$), and their interaction ($F(2,45) = 4.22$, $p = 0.025$, partial $\eta^2 = 0.158$). For the rounded shoulder angle, significant main effects were found for time ($F(1,45) = 19.10$, $p < 0.001$, partial $\eta^2 = 0.298$) and group ($F(2,45) = 15.06$, $p < 0.001$, partial $\eta^2 = 0.401$), as well as a significant time × group interaction ($F(2,45) = 9.92$, $p < 0.001$, partial $\eta^2 = 0.306$). Overall, these results demonstrate that both corrective exercise and ergonomic interventions led to significant postural improvements compared with the control group (Table 5).

Table 5: Results of Repeated Measures ANOVA in the Three Study Groups

Variable	Group	N	Pre-test Mean ± SD	Post-test Mean ± SD	Time Effect	Group Effect	Interaction Effect
Forward Head (°)	CE	16	57.00 ± 5.19	52.60 ± 3.96	$F(1, 45) = 19.38$ $p < 0.001$ partial $\eta^2 = 0.301$	$F(2, 45) = 34.46$ $p < 0.001$ partial $\eta^2 = 0.605$	$F(2, 45) = 15.83$, $p < 0.001$ partial $\eta^2 = 0.413$
	Ergonomic	16	57.13 ± 5.10	52.40 ± 3.33			
	Control	16	56.33 ± 3.60	58.07 ± 3.22			
Kyphosis (°)	CE	16	50.53 ± 3.66	47.26 ± 4.33	$F(1, 45) = 7.08$ $p = 0.013$ partial $\eta^2 = 0.136$	$F(2, 45) = 27.72$ $p < 0.001$ partial $\eta^2 = 0.552$	$F(2, 45) = 4.22$ $p = 0.025$ partial $\eta^2 = 0.158$
	Ergonomic	16	51.50 ± 3.65	46.00 ± 3.16			
	Control	16	51.33 ± 3.71	52.46 ± 4.17			
Rounded Shoulder (°)	CE	16	57.13 ± 2.03	54.81 ± 1.22	$F(1, 45) = 19.1$, $p < 0.001$ partial $\eta^2 = 0.298$	$F(2, 45) = 15.06$ $p < 0.001$ partial $\eta^2 = 0.401$	$F(2, 45) = 9.92$ $p < 0.001$ partial $\eta^2 = 0.306$
	Ergonomic	16	55.27 ± 2.60	50.07 ± 4.11			
	Control	16	56.13 ± 3.34	56.73 ± 2.60			

CE= Corrective Exercises

The Bonferroni post hoc test showed that corrective exercises were the most effective intervention for improving postural abnormalities. Forward head angle was reduced by 5.55° compared to the ergonomic group ($p < 0.001$) and by 7.98° compared to the control group ($p < 0.001$). Corrective exercises also significantly reduced kyphosis by 3.93° compared to ergonomics ($p = 0.001$) and by 7.19° compared to the control group ($p < 0.001$). For rounded shoulders, corrective exercises improved the angle by 3.30° compared to ergonomics ($p < 0.001$), although the change compared to the control group was not significant ($p = 1.000$). The ergonomic intervention reduced kyphosis by 3.27° ($p = 0.007$) and rounded shoulder angles by 3.77° ($p < 0.001$) compared to the control group; however, it did not significantly affect forward head posture ($p = 0.067$). Overall, corrective exercises were significantly more effective than ergonomic adjustments or no intervention in improving head, shoulder, and spinal posture (Table 6).

Table 6: Bonferroni Pairwise Comparisons – Forward Head, kyphosis and Rounded Shoulder Angle

Variable	Comparison		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Forward Head (°)	CE	Ergonomic	5.5479	1.01107	0.000*	3.0291	8.0668
		Control	7.9813	1.01107	0.000*	5.4624	10.5001
	Ergonomic	Control	-2.4333	1.02725	0.067	-4.9925	0.1258
kyphosis (°)	CE	Ergonomic	-3.9250	.98970	0.001*	-6.3906	-1.4594
		Control	-7.1917	.98970	0.000*	-9.6573	-4.7261
	Ergonomic	Control	3.2667	1.00554	0.007*	0.7616	5.7717
Rounded Shoulder (°)	CE	Ergonomic	3.3021	.75547	0.000*	1.4200	5.1842
		Control	-0.4646	.75547	1.000	-2.3467	1.4175
	Ergonomic	Control	-3.7667	.76756	0.000*	-5.6789	-1.8545

CE= Corrective Exercises

4. Discussion

The present study aimed to evaluate the impact of corrective exercises and ergonomic interventions on postural abnormalities in men diagnosed with upper crossed syndrome (UCS). The results indicated that while both approaches improved postural alignment, the pattern and significance of improvements differed between interventions. Corrective exercises produced significant reductions in forward head posture, thoracic kyphosis, and rounded shoulder angles, whereas the ergonomic intervention resulted in significant improvements only in thoracic kyphosis and rounded shoulder angles, with no statistically significant change observed in forward head posture. Importantly, corrective exercises yielded greater overall improvements than ergonomic strategies alone, highlighting their effectiveness in addressing the muscle imbalances and postural deviations characteristic of UCS. However, it should be noted that the corrective exercise group received substantially more supervised contact time (24 hours) compared to the ergonomics education group (4 hours). This considerable difference in intervention exposure may have contributed to the greater improvements observed in the corrective exercise group; therefore, the interpretation of between-group differences should be made with caution.

These findings align with previous studies, which reported comparable reductions in forward head posture, kyphosis, and rounded shoulders. For example, Seidi et al. (2020) and Bayattork et al. (2020), in their randomized controlled trials, found that comprehensive corrective exercise protocols markedly improve posture, muscular activation, and movement quality in men with UCS (14, 16). Similarly, Ahmadi et al. (2022) demonstrated the efficacy of a related water-based intervention, showing that structured corrective exercises are beneficial regardless of environment (30). The congruence in results may stem from several shared factors across studies, such as an 8-week intervention period, NASM-based training protocols, and similarities in participant age and gender. Additionally, the use of objective measurement instruments for postural angles strengthens the comparability of outcomes.

Partial alignment with our findings was observed in other studies, although the magnitude varied. Aneis et al. (2022) employed a multimodal approach that combined muscle energy techniques and postural correction, resulting in improved posture and reduced pain (31). Their observed postural change was less than ours, highlighting a difference. In contrast, Karimian et al. (2021) found that ergonomic education and corrective exercises effectively reduced postural abnormalities and musculoskeletal disorders in schoolteachers (32). Their participants were sedentary professionals, unlike our young, physically active university students. Differences in exercise intensity, participant backgrounds, and occupational factors may explain these varied results and clarify the contrasts between studies.

Conversely, studies by Wright et al. (2000) and Hrysomallis and Goodman (2001) found little or no postural improvement after exercise interventions (33, 34). This divergence likely arises because the prior regimens were broad or poorly designed. They did not target the specific, shortened, and weak muscles typical of UCS, unlike the focused approach employed in this study. Furthermore, some previous studies assessed posture using visual or qualitative methods. These methods are less accurate than the angular or digital techniques applied in this research. Another notable contrast is that prior studies often involved healthy individuals without notable postural dysfunction. This limited the observed improvements, whereas this study focused on young men with Upper Crossed Syndrome. Taken together, discrepancies among studies can largely be explained by differences in intervention protocols, participant populations, and measurement methods. In contrast, this study's integration of corrective exercises with ergonomic instruction stands out as a practical, safe, and cost-effective approach for improving postural alignment. This strategy is easily applicable in prevention or rehabilitation settings across various facilities, including sports, schools, workplaces, and clinics. Overall, combining proper postural education with targeted exercises can measurably improve alignment and enhance both qualities of life and physical performance.

Several limitations should be considered. The modest sample size may have weakened the study’s statistical power and limited generalizability. Participants were only young adult males aged 18 to 30. Thus, the findings may not be applicable to females, adolescents, older adults, or individuals in other professions. There was no follow-up phase, so we cannot draw conclusions about long-term effects. Although the study examined postural angles, it did not directly assess pain intensity, muscle activation, or quality of life. Measuring these outcomes could have provided a more comprehensive picture of the intervention’s impact. Additionally, recruiting from a narrow population may have introduced selection bias and compromised representativeness. Another important limitation is the substantial difference in intervention exposure between groups. The corrective exercise group received considerably more supervised contact time than the ergonomics education group, which may have contributed to the greater improvements observed. Therefore, the interpretation of between-group differences should be made with caution.

Future studies should utilize larger and more diverse samples, as well as incorporate longer follow-ups. Multidimensional evaluation tools and comparing delivery formats (in-person, online, or hybrid) may help create more effective and generalizable training protocols.

5. Conclusion

This study found that corrective exercises led to greater improvements in postural deviations related to Upper Crossed Syndrome than ergonomic interventions or no treatment at all. Specifically, participants in the corrective exercise group showed the most pronounced reduction in forward head posture and kyphosis angles. While both intervention groups experienced some benefit, the structured exercise program demonstrated superior effects, although the substantially greater supervised contact time in the corrective exercise group may have contributed to these outcomes. These results underline the potential of targeted corrective exercises for postural correction in young adults. However, as the study’s sample size was limited and included only male participants, these findings should be generalized with caution. Future research should assess long-term outcomes, include broader populations with both genders and different age groups, and investigate the efficacy of combined corrective and ergonomic approaches across diverse occupational and educational settings.

Limitations

The present study was conducted on high school female basketball athletes with DKV and investigated the short-term effects of basketball

SMs on landing technique and DKV. Therefore, its results cannot be generalized to other age groups, semi-professional and elite levels, and male basketball players because landing technique and types of neuromuscular impairments vary across populations.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

MSA, SM, and KK contributed to the study conception and design. SM performed clinical examination and data collection. MS and KK developed the methodology and statistical analysis design. MS drafted the manuscript. All authors provided critical revisions, contributed to study refinement, and approved the final manuscript.

Ethical considerations

This study was approved by the Human Ethics Research Committee of the Sport Sciences Research Institute of Iran (approval code: IR.SSRC.REC.1403.071) and conducted in accordance with the Declaration of Helsinki. The clinical trial was registered at IRCT with the code IRCT20110803007211N3 on December 31, 2024.

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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