RESEARCH ARTICLE

Comparative Effectiveness of Isometric and Isotonic Exercises on Hyperkyphosis, Forward Head Posture, and Rounded Shoulders in Computer Users with Upper Crossed Syndrome: A Randomized Controlled Trial

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Abstract

Objectives: While strengthening exercises have demonstrated efficacy in improving symptoms associated with Upper Crossed Syndrome (UCS), it remains unclear whether isometric or isotonic modalities offer greater benefits. This study compared their effects on forward head posture (FHP), rounded shoulders (RSH), and thoracic kyphosis in individuals with UCS.

Methods: In this randomized controlled trial, 43 sedentary computer users diagnosed with UCS (aged 30–45 years) were randomly assigned to isometric (n = 15), isotonic (n = 14), or control (n = 14) groups. The eight-week intervention comprised three weekly supervised sessions for both exercise groups, each lasting 40 to 60 minutes. Postural variables were assessed using photogrammetry (FHP, RSH) and a flexible ruler (thoracic kyphosis). Statistical analyses included analysis of covariance (ANCOVA) and Bonferroni-adjusted post hoc tests, with statistical significance set at $\alpha = 0.05$.

Results: Both the isometric and isotonic groups showed statistically significant improvements in FHP ($P < .001$; mean difference [MD] = −6.79° and −7.97°, respectively), RSH ($P < .001$; MD = −6.44° and −8.09°, respectively), and thoracic kyphosis ($P < .001$; MD = −7.21° and −7.39°, respectively), compared to the control group. No statistically significant differences were observed between the two exercises groups, although the isotonic group exhibited marginally greater improvements.

Conclusion: Both isometric and isotonic exercises effectively improved posture-related outcomes associated with UCS among sedentary adults. However, no definitive advantage was observed between the two exercise types. Future studies with longer intervention durations and larger sample sizes may elucidate any clinically meaningful differences.

Level of evidence: I

Keywords: Exercise therapy, Kyphosis, Posture, Upper crossed syndrome

Introduction

The increased reliance on technology and prolonged screen time following the COVID-19 pandemic have contributed to more sedentary lifestyles, resulting in a marked rise in Upper Crossed Syndrome (UCS) prevalence.[1] UCS is a musculoskeletal disorder characterized by forward head posture (FHP ≥ 45°), rounded shoulders (RSH ≥ 52°), elevated or protracted scapulae, and thoracic hyperkyphosis (≥ 42°).[1,2] These postural deviations are typically associated with muscular imbalances, including hyperactivity of the pectoralis major, upper trapezius, and sternocleidomastoid muscles, coupled with hypoactivity of the lower trapezius, rhomboids, and deep cervical flexors such as the longus capitis and longus colli.[3]

Nejati et al. (2014) reported a high prevalence of UCS-related postural dysfunctions among sedentary Iranian

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office workers, with 61.3% exhibiting FHP, 48.7% presenting with protracted shoulders, and 78.3% demonstrating increased thoracic kyphosis.[4] Similarly, UCS symptoms are frequently observed among young adults aged 18–25 years, with FHP reported in 63.96% and forward shoulder posture in 52.9% of individuals.[5,6]

UCS extends beyond a postural abnormality; it is implicated in a range of musculoskeletal disorders, including shoulder impingement, cervicogenic headaches, thoracic outlet syndrome, and rotator cuff pathology.[2,5,7,8] Cervical misalignment associated with UCS may also contribute to cervical radiculopathy or, in more severe cases, cervical myelopathy. Prolonged computer use—one of the primary risk factors for UCS—has been linked to neck pain in up to 67% of users and shoulder pain in more than 50%.[2,9] Chronic overactivation of muscles such as the upper trapezius and levator scapulae further exacerbates these symptoms. These complications underscore the importance of early identification and intervention to prevent long-term functional impairment.[7,8]

Given the risks associated with UCS, understanding its underlying pathophysiology is essential for effective management. Treatment strategies typically involve postural correction, stretching of shortened muscles, and strengthening of weakened muscle groups to mitigate complications and enhance musculoskeletal function.[7] However, a 2024 meta-analysis found no definitive superiority of one exercise modality—stretching, strengthening, or shoulder-based—over the others.[10] While multimodal rehabilitation programs may be appropriate for athletic populations, isolated exercise interventions are often safer and more practical for sedentary individuals in the early stages of rehabilitation, due to a lower risk of injury, reduced pain, and improved adherence.[11,12] These findings emphasize the importance of tailoring exercise prescriptions to individual needs, particularly for patients with postural dysfunction or limited mobility.[12,13]

Recent studies have underscored the efficacy of strengthening exercises in correcting sagittal spinal misalignments, including thoracic hyperkyphosis.[14,15] These interventions encompass isometric exercises involving static muscle contractions that primarily activate Type I slow-twitch fibers in postural muscles, such as the deep cervical flexors and lower trapezius, that are critical for maintaining stability but prone to adaptive shortening.[7] In contrast, isotonic exercises utilize dynamic contractions to target Type II fast-twitch fibers in phasic muscles, such as the middle trapezius and rhomboids, responsible for moving but more susceptible to fatigue.[16] Each modality offers distinct therapeutic benefits, depending on the functional goals and muscular deficits being addressed.[7,16]

Despite the growing body of research supporting exercise therapy for managing UCS,[10,11] no study has directly compared the effects of isometric and isotonic exercise interventions specifically among computer users, a population at risk. Therefore, the present study aimed to: (1) compare the effects of isometric and isotonic exercises with those of a no-intervention control group, and (2) directly assess the efficacy of these exercise modalities in improving FHP, RSH, and thoracic hyperkyphosis in individuals with UCS.

Given UCS's link to prolonged poor posture (e.g., computer use), we hypothesize that isometric exercises—based on static muscle engagement—may be more effective for correcting UCS-related imbalances and dysfunctions. Our null hypothesis is that isometric exercises will improve UCS more than isotonic exercises by enhancing postural stability and endurance, aligning with the condition's pathophysiology.

Materials and Methods

Study design

This randomized clinical trial (RCT) was conducted at the Laboratory of the Faculty of Sports Sciences and Health, University of Tehran, between June 2024 and March 2025. All participants were fully informed about the study procedures and provided written informed consent before enrollment. The study complied with the ethical principles outlined in the Declaration of Helsinki,[17] and received approval from the University of Tehran's Research Ethics Committee (approval code: IR.UT.SPORT.REC.1403.048). The trial was also registered with the Iranian Registry of Clinical Trials (IRCT ID: IRCT20180727040609N3).

Participants

In this RCT, 43 computer users diagnosed with Upper Crossed Syndrome (UCS) were enrolled and randomly assigned to one of three groups: isotonic exercise (n = 14), isometric exercise (n = 15), or a waitlist control group (n = 14). Randomization was computer-generated (www.randomizer.org) and supervised by the study's data analyst (AK). An a priori power analysis using G*Power 3.1 determined that a minimum of 30 participants (10 per group) would be required to achieve 80% statistical power ($\alpha = 0.05$; effect size = 0.88),[18] To account for potential attrition, the sample size was increased to 45 participants [Figure 1].

The Inclusion Criteria

Eligible participants were adults aged 20–60 years, of either sex, with a body mass index (BMI) of less than 30, who demonstrated specific postural abnormalities—rounded shoulders (≥ 52°), forward head posture (≥ 45°), and thoracic kyphosis (≥ 42°).[2] All participants reported at least three years of daily computer use, had no acute musculoskeletal injuries within the preceding six months, and had obtained physician clearance for engaging in light physical activity.[2,4]

The Exclusion Criteria

Exclusion criteria included a history of spinal surgery or neurological disorders; contraindications to light physical activity; pregnancy; cardiovascular or respiratory comorbidities; lumbar hyperlordosis; scoliosis; other clinically significant postural deviations; or anticipated attendance of less than 90%.[2,14,18,19]

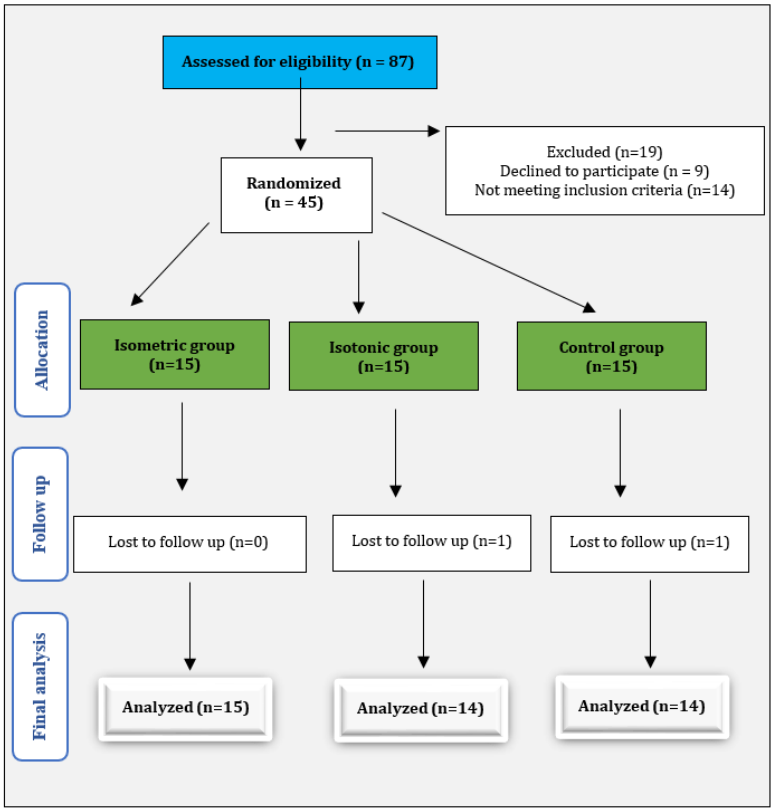

Figure 1. Flow diagram of the participants

Outcome Measures

Measurement of Thoracic Kyphosis Angle

Thoracic kyphosis was assessed using a flexible ruler, demonstrating high reliability (r = 0.89–0.92) and validity (r = 0.91). Participants stood in a relaxed posture with the upper torso exposed. The spinous processes of the T2 and T12 vertebrae were palpated and marked. The flexible ruler was then molded along the thoracic curvature without leaving any gaps [Figure 2, left]. The ruler's curve was transferred onto paper by marking the corresponding points to trace the spinal contour. The linear distance (L) between T2 and T12 and the maximum sagittal depth (H) of the curve were measured [Figure 2, right]. The thoracic kyphosis angle (Θ) was calculated using the formula $\Theta = 4 \arctan(2H/L)$, which provides precise and reproducible measurements with minimal inter-rater variability.[20]

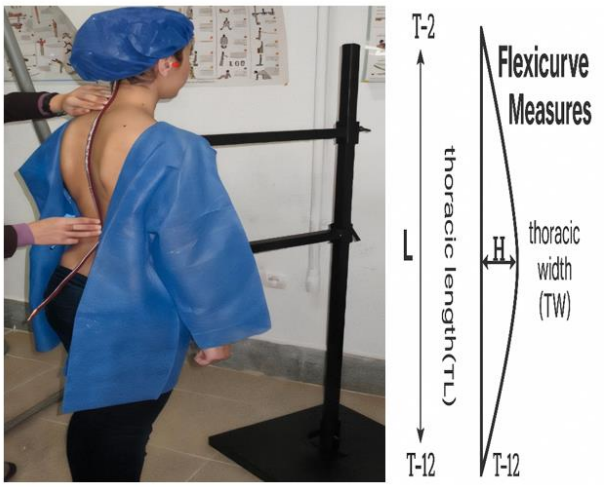

Figure 2. Flexible ruler placement for kyphosis angle measurement (left) and L/H line depiction method (right)

Measurement of Forward Head and Forward Shoulder Angles

The craniovertebral angle (forward head angle) and scapular position angle (forward shoulder angle) were photographically measured for sagittal alignment (high reproducibility; intra-rater ICCs: 0.87 and 0.96; inter-rater ICCs: 0.66 and 0.78, respectively).[21] Landmarks: tragus, acromion, C7 spinous process. Participants stood 23 cm from a wall, with the camera placed 265 cm away and aligned with the acromion. After three forward flexions and shoulder abductions, a lateral photo was taken after five seconds of target focus. Angles were analyzed using SCODIAC software (available for free at https://www.ortotika.cz/download/SetupSCODIAC_Full.zip).[18] The craniovertebral angle was defined as the angle between the tragus–C7 line and a vertical line. The scapular position angle was defined as the angle between the C7–acromion line and the same vertical line [Figure 3]. The average of the three measurements was recorded for each angle.[4,11]

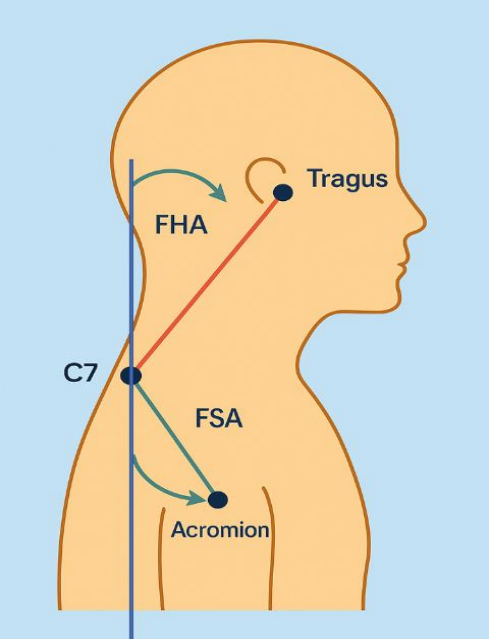

Figure 3. Measurement of Forward Head Angle (FHA) and Forward Shoulder Angle (FSA)

Interventions

Participants were randomly assigned to a control group or one of two intervention groups (isometric or isotonic training). All participants received postural hygiene education, while the intervention groups completed an eight-week, home-based exercise program structured according to the FITT principles: Frequency (3 sessions per week), Intensity (isometric: 20–45 second holds; isotonic: 10–20 repetitions), Time (5–7 minutes warm-up, 40–50 minutes main session, 3–5 minutes cool-down), and Type (isometric: static holds; isotonic: dynamic movements).[9,16]

The first session included live demonstrations, visual aids, and instructional videos, followed by a technique check with a specialist. Participants subsequently trained independently at home, and adherence was monitored biweekly through online surveys and phone calls. The exercises targeted the neck, shoulder, and thoracic musculature, including lying cobra, floor T/Y/W raises, bird-dog, and seated corrective movements such as chin tucks, scapular retractions, and thoracic extensions [Figure 4].[22] The control group was waitlisted for eight weeks and received clinical monitoring.

Statistical Analyses

This study summarized the data using descriptive statistics, including percentages, mean values, and standard deviations. For hypothesis testing, analysis of covariance (ANCOVA) was conducted. Group comparisons were performed using the Bonferroni post hoc test, with the significance level set at 0.05. Graphical representations of the data were generated using PrismPad9 software.

Results

This section presents the demographic and physical characteristics of the participants, including weight, age, body mass index (BMI), forward head posture (FHP) angle, rounded shoulders (RSH) angle, and thoracic kyphosis. These characteristics, along with the results of the group homogeneity analysis, are summarized in [Table 1].

Covariance analysis revealed a statistically significant difference in mean FHP angle among the three study groups ($F(2, 39) = 27.17$, $P < .001$, $\eta^2 = 0.58$). Post hoc comparisons, summarized in Table 2, indicated that the FHP angle in both the isometric and isotonic groups was significantly lower than that of the control group ($P < 0.001$; mean difference [MD] = −6.79º and −7.97º, respectively). However, no significant difference was found between the isometric and isotonic groups ($P = .999$; MD = 1.18º) [Table 2].

Similarly, a statistically significant difference was observed in the mean RSH angle across the three groups ($F(2, 39) = 39.69$, $P < 0.001$, $\eta^2 = 0.67$). Post hoc tests indicated that the RSH angle was significantly lower in both the isometric and isotonic groups compared to the control group ($P < 0.001$; mean difference [MD] = −6.44º and −8.09º, respectively). As with FHP, no significant difference was found between the isometric and isotonic groups ($P = 0.400$; MD = 1.65º) [Table 2].

Finally, a statistically significant difference was observed in the mean kyphosis angle across the three groups ($F(2, 39) = 73.41$, $P < 0.001$, $\eta^2 = 0.79$). The kyphosis angle was significantly lower in both the isometric and isotonic groups compared to the control group ($P < 0.001$; mean difference [MD] = −7.21º and −7.39º, respectively). No significant difference was found between the isometric and isotonic groups ($P = .999$; MD = 0.17º) [Table 2].

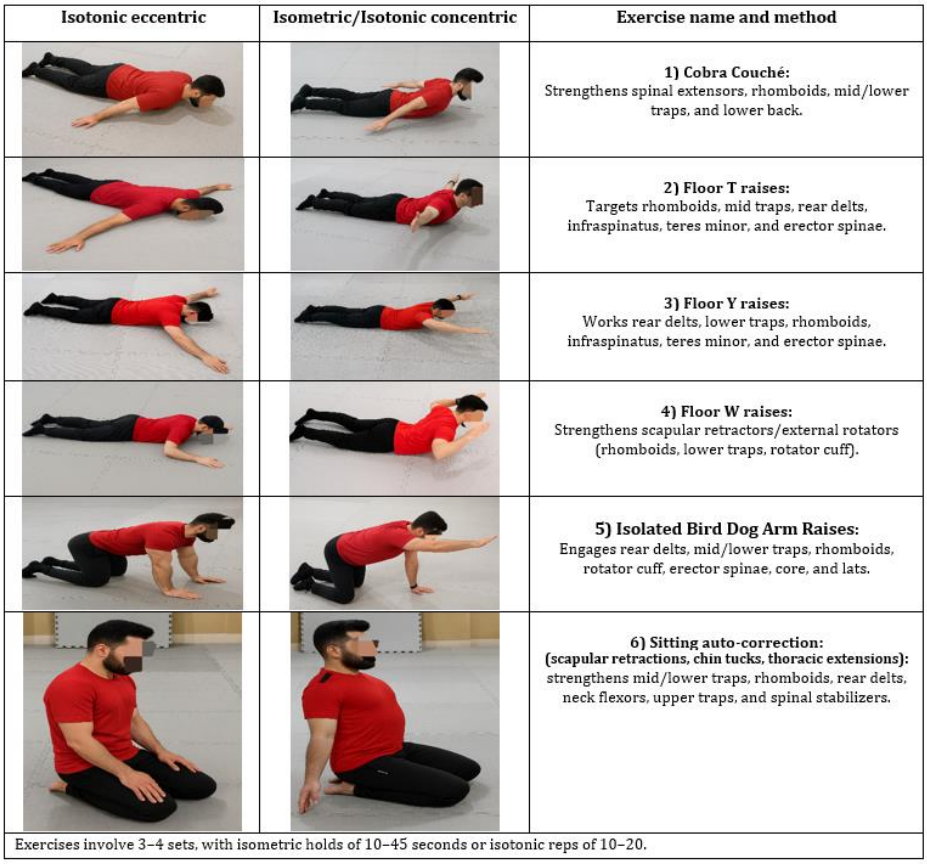

Figure 4. Isometric and Isotonic Exercise Program

Table 1. Comparison of patients' characteristics between groups

Variables	Isometric (n=15)	Isotonic (n=14)	Control (n=14)	p value
Age (years)	39.13±7.15	36.86±9.71	35.86±7.43	0.544[NS]
Weight (kg)	74.80±9.75	77.29±9.37	76.29±9.08	0.059[NS]
BMI (kg/m2)	28.67±4.73	26.41±2.26	26.89±3.45	0.224[NS]
FHP angle	54.9±4.10	45.1±2.31	53.27±3.49	0.018
RSH angle	62.49±3.62	58.11±2.17	60.02±4.17	0.005
Kyphosis angle	50.69±3.99	47.39±2.81	48.44±3.83	0.051

NS is non-significant, as is BMI, body mass index, FHP, forward head posture, and RSH, rounded shoulders.

Table 2 Results of Bonferroni post-hoc test (Mean ± SD)

Variables	Intervention time	Isometric (n=15)	Isotonic (n=14)	Control (n=14)	p value
FHP angle	*Pre*	54.90±4.10	51±2.61	53.32±3.64	<0.001
	Post	46.46±0.83 [C]	45.29±0.87 [C]	53.25±0.82	
RSH angle	*Pre*	62.49±3.62	58.11±2.17	60.02±4.17	<0.001
	Post	53.51±0.71 [C]	51.86±0.72 [C]	59.95±0.68	
Kyphosis angle	*Pre*	50.69±3.99	47.39±2.81	48.44±3.83	<0.001
	Post	41.36±0.50 [C]	41.19±0.51 [C]	48.57±0.50	

FHP forward head posture, RSH rounded shoulders
[C] p≤0.001, significant difference with the control group

Discussion

This study compared the effects of isometric and isotonic exercises targeting posterior trunk extensors on forward head posture (FHP), rounded shoulders (RSH), and thoracic hyperkyphosis in adults with Upper Crossed Syndrome (UCS) associated with prolonged computer use. Both exercise groups demonstrated significant improvements in postural alignment compared to the control group. Contrary to the initial hypothesis, no statistically significant difference was observed between the isometric and isotonic interventions. However, the isotonic group showed a slight advantage in reducing FHP, RSH, and kyphosis angles. These findings contribute to the existing literature and offer new insights into the conservative management of UCS.

Consistent with prior research,[2,10,11,14,15] strengthening exercises targeting the trunk, cervical, and thoracic extensors—both isometric and isotonic—significantly improved postural alignment in computer users with UCS (all $P < 0.001$). FHP improved by 6.79° in the isometric group and 7.97° in the isotonic group; rounded shoulders improved by 6.44° (isometric) and 8.09° (isotonic); and thoracic kyphosis improved by 7.21° (isometric) and 7.39° (isotonic). Although the differences were not statistically significant, the isotonic group showed numerically greater improvements, contrary to the initial hypothesis.

These findings support the perspective of Lederman et al., who proposed that dynamic exercises may outperform static approaches in managing musculoskeletal conditions such as UCS. Their rationale suggests that dynamic training enhances proprioceptive feedback, joint position awareness, and neuromuscular control—benefits that are not fully replicated by isometric exercises, which primarily target muscular endurance rather than dynamic stability. This theoretical framework is consistent with the results of the present study.[23]

A 2025 study by Mokhtaran et al. compared the NASM (National Academy of Sports Medicine) protocol with targeted strengthening exercises for addressing FHP, RSH, and thoracic hyperkyphosis. The study found no significant superiority between the two approaches. The NASM protocol, which incorporates inhibitory, lengthening, strengthening, and integration techniques, was contrasted with exercises specifically targeting flexor and extensor mechanisms. This methodological distinction may account for the absence of significant differences in outcomes, which contrasts with the present study's findings.[24]

Another study evaluated the effects of strengthening, stretching, and combination exercises on FHP over six weeks. The results indicated a 10% reduction in FHP with strengthening exercises, 8% with stretching, and 13% with combination exercises, although no statistically significant differences were observed between the groups. This aligns with the present findings, as combination exercises (strengthening with stretching) did not demonstrate a clear advantage over strengthening alone. Notably, the strengthening exercises in that study employed resistance bands and incorporated isotonic movements targeting the shoulder girdle.[25]

Isotonic exercises involve dynamic movements through a full range of motion (ROM), improving flexibility, strength, and postural alignment by enhancing muscle elasticity, joint mobility, and correcting imbalances (e.g., rows and shoulder retractions for RSH and FHP.[26] Being functional and mimicking real-life movements (e.g., pull-ups and squats) promotes postural stability, reduces compensatory movements, and fosters balanced muscular development.[23] Furthermore, isotonic exercises enhance blood flow, aiding tissue repair, recovery, and growth, which is beneficial for correcting postural imbalances by strengthening weak muscles and lengthening tight ones. Empirical evidence supports their effectiveness for postural correction, injury prevention, and improving functional strength.[27]

Conversely, Janda et al. described UCS as a muscular imbalance between overactive phasic muscles (e.g., upper trapezius, pectoralis major) and underactive tonic muscles (e.g., deep cervical flexors, lower trapezius, rhomboids)[7], commonly observed in individuals with prolonged poor sitting postures, such as extensive computer users. Isometric exercises involving sustained contractions without joint movement effectively activate and strengthen underutilized postural muscles. They specifically target key stabilizers such as the deep cervical flexors and scapular stabilizers to address postural imbalances.[16]

Collectively, the findings of these studies,[2,10,11,14,15,24,25] supported by a 2024 review and meta-analysis,[10] suggest that current evidence is insufficient to favor any isolated training modality, particularly isometric or isotonic strengthening. Moreover, direct comparisons between these modalities remain limited. As demonstrated in the present study, longer intervention durations (e.g., ≥12 weeks) may yield more definitive outcomes. Therefore, additional randomized controlled trials (RCTs) on UCS are essential to establish stronger and more conclusive evidence.

This study has several limitations that may affect the results. First, the small sample size reduces statistical power, limiting the ability to detect significant differences between the training methods. Second, the absence of long-term follow-up restricts understanding whether the observed improvements are maintained over time (e.g., beyond 12 weeks).[28] Third, uncontrolled lifestyle factors—such as sedentary behavior or engagement in additional physical activities—may have confounded the results.[29] Fourth, the lack of blinding for therapists and participants could have introduced bias.[30] Future studies should address these limitations by increasing sample sizes, extending follow-up periods, controlling for lifestyle variables, and implementing blinding procedures to enhance the findings' internal validity and reliability.

Conclusion

Both isometric and isotonic exercises significantly improved forward head posture (FHP), rounded shoulders (RSH), and thoracic hyperkyphosis in computer users with Upper Crossed Syndrome (UCS), compared to no intervention. Although isotonic exercises demonstrated a slight, non-significant advantage, longer-duration studies

are needed to draw more definitive comparisons. Both exercise modalities—considered safe and low-risk—are viable isolated strategies for addressing UCS-related postural impairments, particularly when targeting this population's posterior neck, shoulder, and back extensor muscles.

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Authors Contribution: AK and HM made significant contributions to the study's design and conception. AK and HM were involved in conducting the investigation, while AK performed the data analysis. AK drafted the manuscript and provided critical revisions. Both AK and HM approved the final version for publication. All authors participated in discussing the results and contributed to the final manuscript.

Declaration of Conflict of Interest: The author(s) do NOT have any potential conflicts of interest for this manuscript.

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Declaration of Ethical Approval for Study: Ethical approval for the study was granted by the Research Ethics Committee of the Faculty of Sports Sciences and Health at the University of Tehran (approval code: IR.UT.SPORT.REC.1403.048). Furthermore, the trial was officially registered with the Iranian Registry of Clinical Trials (IRCT) under the identifier IRCT20180727040609N3.

Declaration of Informed Consent:

Written informed consent was obtained from all participants after explaining the study's purpose, procedures, and their right to withdraw at any time.

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