



Isometric or Isotonic Exercises in Alleviating Chronic Neck and Shoulder Pain and Enhancing Quality of Life Among Computer Users with Upper Crossed Syndrome: A Randomized Controlled Trial

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Received: 24 February, 2025; Revised: 23 April, 2025; Accepted: 7 May, 2025

Abstract

Background: Millions of computer users experience chronic neck and shoulder pain (CNSP) and reduced health-related quality of life (HRQoL) due to upper cross syndrome (UCS). While strengthening exercises for the posterior trunk alleviate symptoms, it remains unclear whether isometric or isotonic exercises are more effective.

Objectives: This study aimed to compare the effects of isometric and isotonic exercises on CNSP and HRQoL in individuals with UCS, and to evaluate these outcomes against a non-intervention group.

Methods: In this randomized clinical trial (RCT), 43 UCS patients with CNSP were divided into three groups: Isometric exercises ($n = 15$), isotonic exercises ($n = 14$), and a control group ($n = 14$). Over 8 weeks, exercise groups completed 3 sessions per week (40 - 60 minutes each). Pain was assessed using the Visual Analog Scale (VAS) and HRQoL was assessed using the 36-item short form health survey (SF-36) questionnaire, both pre- and post-intervention.

Results: Both isometric and isotonic exercises significantly reduced CNSP and improved HRQoL compared to the control group. Isometric exercises yielded a 70.4% pain reduction ($P < 0.001$) and a 14.9% HRQoL improvement ($P = 0.002$), while isotonic training showed a 47.6% pain reduction ($P = 0.001$) and a 17.7% HRQoL improvement ($P < 0.001$). Between-group differences were not statistically significant (pain: $P = 0.853$; HRQoL: $P = 0.999$). Although isometric exercises slightly favored pain reduction and isotonic exercises showed marginal HRQoL gains, these differences should not be overstated.

Conclusions: Both isometric and isotonic exercises improved CNSP and HRQoL in UCS patients, with no significant difference between them. Slight trends favoring each should be interpreted cautiously. Longer-term studies are warranted.

Keywords: Upper Cross Syndrome, Exercise Therapy, Neck Pain, Shoulder Pain, Quality of Life

1. Background

Technological advancements and increased post-COVID-19 screen time have fueled sedentary lifestyles, significantly contributing to the rising prevalence of upper crossed syndrome (UCS). Upper crossed syndrome is a musculoskeletal condition marked by forward head posture (cervical angle $\geq 45^\circ$), rounded shoulders (acromial angle $\geq 52^\circ$), elevated and protracted scapulae, and increased thoracic kyphosis (Cobb angle $\geq 42^\circ$), resulting from muscle imbalances (1, 2): Hypertonic pectorals, levator scapulae, and upper

trapezius, alongside weak middle/lower trapezius and deep cervical flexors (3).

Epidemiological data further highlight the impact of UCS, particularly among sedentary office workers. Nejati et al. reported high incidences of forward head posture (FHP) (61.3%), rounded shoulders (48.7%), and hyperkyphosis (78.3%) in this population, associated with symptoms such as myofascial pain, paresthesia, restricted range of motion (ROM), and reduced health-related quality of life (HRQoL) (4). Similarly, prolonged computer use is strongly correlated with neck pain

(affecting up to 67% of adults) (5), and shoulder pain (reported by 50.5% of users) (2).

To address UCS and its associated chronic neck and shoulder pain (CNSP), various therapeutic options are available, including physiotherapy, pharmacological treatments, behavioral interventions, targeted exercises, and surgery in severe cases (6, 7). Notably, therapeutic exercise is a prominent approach due to its cost-effectiveness, non-invasiveness, and capacity to correct underlying muscular imbalances (2, 6), demonstrating effectiveness in reducing nociceptive pain and improving HRQoL (2, 8).

Although various exercise approaches—such as stretching and strengthening—have proven beneficial (2, 6, 8), a 2024 review found no single best method (6). Strengthening may be superior to stretching for spinal deformities and pain (9, 10), but the optimal type (isometric vs. isotonic) is unknown. These simpler exercises are safer for those with poor physical conditioning (6, 9, 10).

Isometric exercises are static muscle contractions without joint movement, primarily engaging slow-twitch (type I) fibers in postural muscles (e.g., deep cervical flexors, lower trapezius). These muscles stabilize the body, but chronic shortening can lead to dysfunctional movement and pain. Conversely, isotonic exercises involve dynamic contractions with joint movement, activating fast-twitch (type II) fibers in phasic muscles (e.g., middle trapezius, rhomboids), crucial for force but prone to fatigue and weakness from disuse (11).

Despite growing interest and theoretical support (2, 9, 10), a crucial clinical question remains: Which type of strengthening exercise—*isometric* or *isotonic*—is more effective in alleviating CNSP and enhancing HRQoL in individuals with UCS? Identifying the optimal exercise type for this increasingly prevalent condition in sedentary populations could significantly improve rehabilitation and reduce musculoskeletal burden. While research exists, direct comparisons between isometric and isotonic strengthening for UCS are limited (6), highlighting the need for further investigation (2, 9, 10). Notably, no prior studies have directly compared these modalities in this specific context.

2. Objectives

(1) Assess the efficacy of isometric exercises compared to no intervention; (2) evaluate the efficacy of isotonic exercises compared to no intervention; (3) directly

compare the effects of isometric and isotonic exercises on CNSP and HRQoL in individuals with UCS.

3. Methods

3.1. Study Design

This randomized clinical trial (RCT) was conducted at the University of Tehran's Faculty of Sports Sciences and Health Laboratory from June 2024 to March 2025, with ethical approval (IR.UT.SPORT.REC.1403.048) and in accordance with the Declaration of Helsinki. All participants provided written informed consent, and the trial was registered (IRCT20180727040609N3).

3.2. Participants

Forty-three computer users with UCS and chronic neck/shoulder pain (≥ 3 hours/day computer use for ≥ 3 years) (12) completed the 8-week intervention. Participants were randomized into two intervention groups (isometric, $n = 15$; isotonic, $n = 14$) and one control group ($n = 14$) using [Research Randomizer](#). Power analysis (G*Power 3.1, 80% power, $\alpha = 0.05$, effect size = 0.88) (13) recommended 30 participants; 45 were recruited to account for attrition (2 dropped out) (Figure 1).

3.3. Inclusion Criteria

Participants [aged 20 - 60, body mass index (BMI) ≤ 30] had postural deviations characterized by forward head posture ($\geq 45^\circ$), rounded shoulders ($\geq 52^\circ$), and rounded back ($\geq 42^\circ$). They reported computer use of more than 3 hours per day for at least 2 years and experienced chronic neck/shoulder pain with a Visual Analog Scale (VAS) score of ≥ 3 for a duration of at least 3 months (2).

3.4. Exclusion Criteria

Exclusions included recent treatments for CNSP within the past 3 months (7), non-mechanical causes of CNSP, spinal pathologies (e.g., fractures, surgery, inflammation), systemic diseases (e.g., fibromyalgia, osteoporosis), pregnancy, continuous use of pain medication, or non-compliance with the study protocol (attendance of less than 90%) (2, 13).

3.5. Outcome Measures

3.5.1. Assessment of Pain Intensity

Pain intensity was assessed using a 100-mm VAS. Participants indicated their current pain level by

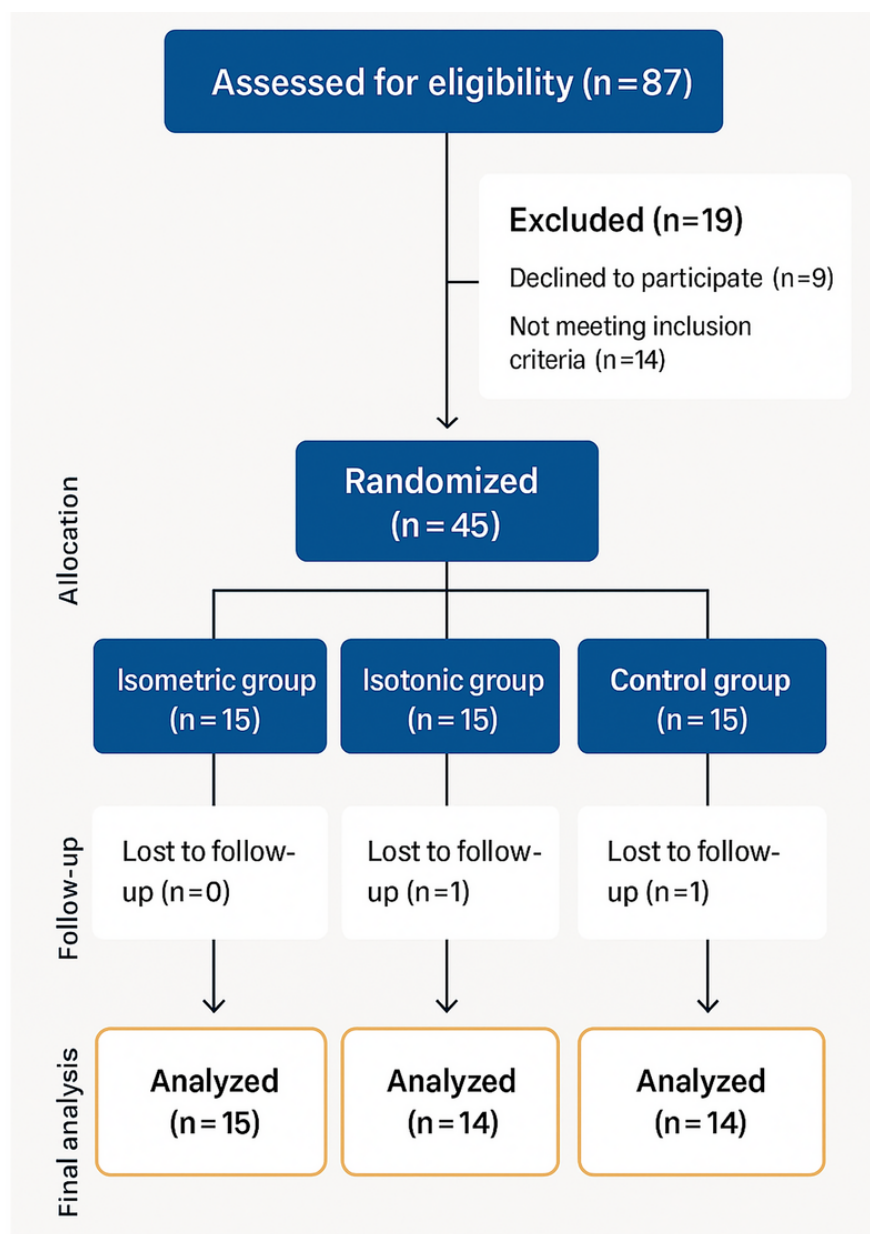


Figure 1. Flow diagram of the patients

marking a point on a line that ranges from 0 (representing no pain) to 10 (representing the worst imaginable pain). This measurement tool has demonstrated strong inter-rater reliability ($ICC = 1.00$) and test-retest reliability ($ICC = 0.99$) in previous studies (14).

3.5.2. Assessment of the Level of Health-Related Quality of Life

Health-related quality of life was assessed using the validated Persian version of the 36-item short form health survey (SF-36). This tool evaluates self-perceived health across eight domains: (1) Physical functioning; (2) role limitations due to physical health; (3) role

Isometric/isotonic concentric	Isotonic eccentric	Exercise name and method
		1. Cobra couché: To strengthen the spinal extensors, rhomboids, middle and lower trapezius, and lower back muscles.
		2. Floor T raises: To strengthen the rhomboids, middle trapezius, posterior deltoid, infraspinatus, teres minor, and erector spinae muscles.
		3. Floor Y raises: To strengthen the posterior deltoid, lower trapezius, rhomboids, infraspinatus, teres minor, and erector spinae muscles.
		4. Floor W raises: To strengthen the scapular retractors and external rotators, targeting the rhomboids, lower trapezius, and rotator cuff muscles.
		5. Isolated Bird Dog Arm Raises: To strengthen the posterior deltoid, middle and lower trapezius, rhomboids, infraspinatus, teres minor, erector spinae, core muscles, and latissimus dorsi (lats).
		6. Sitting auto-correction exercises (scapular retractions, chin tucks, and thoracic extensions): To strengthen the middle and lower trapezius, rhomboids, posterior deltoid, deep cervical flexors, upper trapezius and suboccipital muscles, erector spinae, and multifidus.
The exercises are performed in 3 to 4 sets. For the isometric group, the isometric contraction is maintained for 10 to 45 seconds, while for the isotonic group, concentric and eccentric contractions are performed for 10 to 20 repetitions.		

Figure 2. Isometric and isotonic exercise program

limitations due to emotional problems; (4) energy/fatigue; (5) emotional well-being; (6) social functioning; (7) bodily pain; and (8) general health. Participants received clear instructions and sufficient time to complete the survey. Scores range from 0 to 100, with higher scores reflecting better health status. The SF-36 has demonstrated good validity (70 - 85%) and

reliability (Cronbach's $\alpha = 0.65 - 0.90$) in Iranian populations (15).

3.5.3. Interventions

Participants were divided into three groups: A control group and two intervention groups (isometric and isotonic exercise). All participants received

Table 1. Comparison of Patients' Characteristics Between Groups

Variables	Isometric Group (n = 15)	Isotonic Group (n = 14)	Control Group (n = 14)	P-Value
Age (y)	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}
Height (cm)	162.07 ± 8.51	171.21 ± 12.08	168.86 ± 10.51	0.775 ^{NS}
BMI (kg/m ²)	28.67 ± 4.73	26.41 ± 2.26	26.89 ± 3.45	0.224 ^{NS}

Abbreviations: NS, non-significant; BMI, body mass index.

Table 2. Results of Bonferroni Post-Hoc Test ^a

Variables and Intervention Time	Isometric (n = 15)	Isotonic (n = 14)	Control (n = 14)	P-Value
Pain (score)				< 0.001
Pre	5.60 ± 1.55	5.93 ± 1.69	5.93 ± 1.64	
Post	3.38 ± 0.033 ^b	3.90 ± 0.35 ^b	5.76 ± 0.35	
SF-36 (score)				< 0.001
Pre	43.73 ± 4.82	43.71 ± 5.95	42.57 ± 3.99	
Post	53.11 ± 1.42 ^b	51.39 ± 1.47 ^b	43.71 ± 1.47	

Abbreviation: SF-36, 36-item short form health survey.

^a Values are expressed as mean ± SD.

^b P ≤ 0.001 significant difference with control group.

standardized educational materials on postural hygiene via a booklet to control for attention/time effects and ensure ethical parity. Additionally, the intervention groups received a second booklet outlining their specific exercise protocols. The control group was placed on an 8-week waitlist and monitored for changes, in line with ethical guidelines (5, 11).

The two intervention groups completed an 8-week exercise therapy program, three times a week. Sessions included a 5 - 7 minute warm-up, 40 - 50 minute main exercise, and 3 - 5 minute cool-down, totaling 40 - 60 minutes, following FITT principles (Appendix 1 Supplementary File) (5). The first session focused on teaching correct movements using demonstrations, images, and videos. The second session was supervised by a specialist to ensure proper execution. Participants then continued independently at home, with adherence monitored via bi-weekly online check-ins and phone follow-ups. They reported exercise frequency, duration, challenges, and compliance. Non-adherent participants were excluded, ensuring a per-protocol analysis.

Both groups performed six exercises targeting shoulder, neck, and thoracic spine extensor muscles: (1) Cobra Couché; (2) floor T raises; (3) floor Y raises; (4) floor W raises; (5) isolated bird dog arm raises; and (6) sitting auto-correction exercises (scapular retractions, chin tucks, thoracic extensions) (16). The isometric

group held static positions, while the isotonic group performed dynamic movements (11) (Figure 2).

3.6. Statistical Analyses

To describe the data in this study, descriptive statistical indicators such as percentages, mean, and standard deviation were used. In the inferential statistics section, analysis of covariance (ANCOVA) was applied to test the hypotheses. Finally, the Bonferroni post hoc test was used to compare groups at a significance level of 0.05.

4. Results

4.1. Participant Characteristics

Table 1 summarizes patient characteristics across the three groups. The ANOVA revealed no statistically significant differences between groups for age (P = 0.544), weight (P = 0.059), height (P = 0.775), or BMI (P = 0.224).

4.2. Pain Scores

Numerically, the isometric group demonstrated the lowest pain levels (3.38 ± 0.33), followed by the isotonic group (3.90 ± 0.35), while the control group reported

the highest pain scores (5.76 ± 0.35). Although this pattern suggests a potential trend favoring isometric exercises for pain reduction, statistical analysis indicated no significant difference between the two intervention groups ($P = 0.853$). However, ANCOVA revealed a significant overall difference in pain scores among the groups ($F(2, 39) = 13.37, P < 0.001, \eta^2 = 0.41$).

Post-hoc comparisons showed that both the isometric and isotonic groups had significantly lower pain than the control group (isometric vs. control: $P < 0.001$, 70.4% reduction, 95% CI: -3.59 to -1.17; isotonic vs. control: $P = 0.001$, 47.6% reduction, 95% CI: -3.08 to -0.64). In contrast, no significant difference was observed between the isometric and isotonic groups ($P = 0.853$, 15.4% difference, 95% CI: -1.73 to 0.68) (Table 2).

4.3. Health-Related Quality of Life

Figure 3 displays the SF-36 HRQoL outcomes across all eight subscales. Numerically, the isotonic exercise group demonstrated the greatest improvements, showing benefits across all measured domains, including physical functioning, pain reduction, and mental health. The isometric group exhibited moderate yet meaningful improvements, particularly in the general health and physical limitation subscales, though to a lesser degree than the isotonic group. In contrast, the control group showed minimal changes across all HRQoL dimensions.

The ANCOVA revealed statistically significant between-group differences in overall HRQoL scores ($F(2, 39) = 11.79, P < 0.001, \eta^2 = 0.38$). Post-hoc analysis confirmed that both exercise interventions significantly improved HRQoL compared to the control group (isotonic: $P < 0.001$, 17.7% improvement, 95% CI: 2.48 to 12.88; isometric: $P = 0.002$, 14.9% improvement, 95% CI: 4.29 to 14.51). However, direct comparison between the two exercise modalities showed no statistically significant difference ($P = 0.999$, 3.2% difference, 95% CI: -3.37 to 6.81).

5. Discussion

This study compared isometric and isotonic exercises for CNSP and HRQoL in computer users with UCS. Over eight weeks, isometric exercises reduced pain more effectively, while isotonic exercises slightly improved HRQoL. Both exercise interventions outperformed the control group, with no significant differences between them. The findings highlight the benefits of tailored exercise for UCS.

Both exercise groups showed significant pain reduction compared to controls—70.4% for isometric (P

< 0.001) and 47.6% for isotonic ($P = 0.001$). Although the isometric group had a greater effect (15.4% difference), the between-group difference was not significant ($P = 0.853$). These findings align with prior studies on neck (2, 17-19) and shoulder pain (2, 20, 21). The non-significant trend favoring isometric exercises aligns with findings from some studies (11, 19), suggesting that pain relief in UCS may involve complex biomechanical and neurophysiological mechanisms.

Prolonged computer use demands sustained activation of postural stabilizers (e.g., trapezius, levator scapulae, rhomboids), making isometric exercises highly relevant. These exercises enhance strength and local endurance without joint motion, benefiting those with chronic pain or hypermobility by reducing nociceptive input and microtrauma risk (2, 19, 20). Unlike concentric/eccentric loading, isometric exercises enable targeted recruitment without aggravating tendinopathy, bursitis, or myofascial pain (11, 20, 21). The lack of cyclic loading also lowers overuse injury risks (e.g., tendinosis, stress fractures), crucial for pain-sensitive individuals with potential central/peripheral sensitization (20, 22).

Comparative studies offer additional insights. Kinsella et al. found comparable effects for isotonic and isometric exercises in subacromial pain syndrome and rotator cuff tendinopathy, likely due to isotonic exercises' functional nature (20). However, their population involved repetitive motion injuries, unlike UCS, which arises from sustained poor posture. In contrast, Fatima et al. reported superior efficacy of isometrics for subacromial impingement, linking it to reduced rotator cuff stress, aligning with our findings (22).

Regarding HRQoL, both interventions significantly improved SF-36 scores versus controls. While the isotonic group demonstrated a slightly higher percentage improvement (17.7%, $P < 0.001$) than the isometric group (14.9%, $P = 0.002$), this comparison is based on change scores rather than absolute post-intervention values, and the difference between the two intervention groups was not statistically significant ($P = 0.999$). These findings align with previous studies on strengthening exercises and HRQoL (6, 23, 24). However, the unblinded design may have introduced bias in subjective measures, as the isotonic group's preference for dynamic movements could have influenced self-reports.

Lederman maintains that dynamic-active exercises (e.g., isotonic) more effectively activate sensorimotor systems and enhance proprioceptive feedback, thereby improving functional performance (25). In contrast,

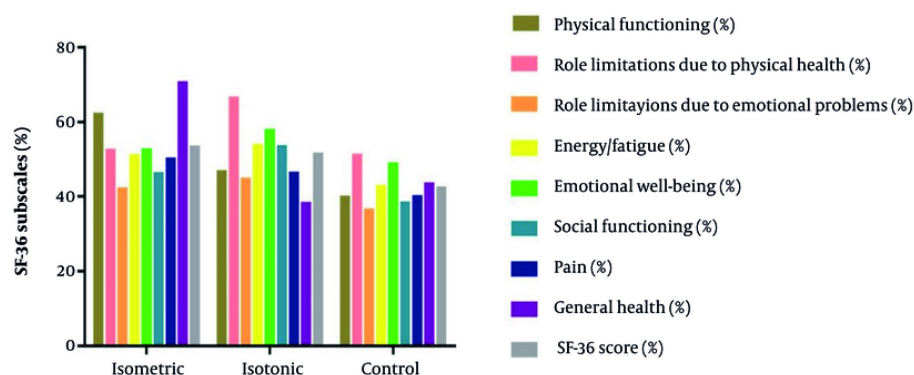


Figure 3. The subscales for 36-item short form health survey (SF-36) health-related quality of life in patients with upper cross syndrome after the intervention

pain reduction appears to exert a more pronounced effect on HRQoL through its facilitation of daily activities (26). This distinction clarifies why both exercise modalities yielded similar HRQoL benefits, notwithstanding their differences in movement complexity and neuromuscular requirements.

The 8-week study may have been too short to identify long-term effects, and a longer duration (e.g., 12+ weeks) could provide clearer insights. However, since pain and quality-of-life improvements were similar between groups, neither exercise type showed clear superiority. Larger, longer-term RCTs are needed for more definitive conclusions.

The study has several limitations:

- (1) Uncontrolled daily environments may have affected outcomes (2).
- (2) The short duration limits long-term efficacy assessment.
- (3) Lack of blinding risks performance/detection bias.
- (4) Physiological mechanisms (e.g., muscle activation) were not examined.
- (5) The reliance on subjective measures without objective assessments (e.g., posture analysis, muscle strength testing) limits the robustness of the conclusions.

Addressing these limitations in future studies would improve the evidence and practical application.

5.1. Conclusions

Both isometric and isotonic exercises effectively reduced CNSP and improved HRQoL in computer users

with UCS compared to the control group. Although isometric exercise demonstrated a trend toward greater pain reduction and isotonic exercise showed a marginal HRQoL improvement, these differences were not statistically significant and should be interpreted cautiously. Future studies with larger sample sizes and longer durations are needed to determine whether one approach is superior. Clinically, however, both exercise types appear beneficial for alleviating UCS symptoms.

Supplementary Material

Supplementary material(s) is available [here](#) [To read supplementary materials, please refer to the journal website and open PDF/HTML].

Footnotes

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

Clinical Trial Registration Code: [IRCT20180727040609N3](#).

Conflict of Interests Statement: The authors declared no conflict of interests.

Data Availability: The dataset presented in the study is available on request from the corresponding author during submission or after its publication. The data are not publicly available due to privacy concerns and ethical restrictions related to participant confidentiality.

Ethical Approval: This study is approved under the ethical approval code of [IR.UT.SPORT.REC.1403.048](#).

Funding/Support: This research was carried out as part of the postdoctoral project of the first author, A. K., at the Faculty of Sports Sciences and Health, University of Tehran, with financial support provided by the University of Tehran.

Informed Consent: Written informed consent was obtained from all participants.

References

- Chang MC, Choo YJ, Hong K, Boudier-Reveret M, Yang S. Treatment of Upper Crossed Syndrome: A Narrative Systematic Review. *Healthcare (Basel)*. 2023;**11**(16). [PubMed ID: 37628525]. [PubMed Central ID: PMC10454745]. <https://doi.org/10.3390/healthcare11162328>.
- Yaghoobitajani Z, Gheitsi M, Bayattork M, Andersen LL. Corrective exercises administered online vs at the workplace for pain and function in the office workers with upper crossed syndrome: randomized controlled trial. *Int Arch Occup Environ Health*. 2022;**95**(8):1703-18. [PubMed ID: 35391580]. [PubMed Central ID: PMC8989105]. <https://doi.org/10.1007/s00420-022-01859-3>.
- Khosravi Z, Mohammad Ali Nasab Firouzjah E, Firouzjah MH. Comparison of balance and proprioception of the shoulder joint in girls with and without upper cross syndrome. *BMC Musculoskelet Disord*. 2024;**25**(1):618. [PubMed ID: 39095725]. [PubMed Central ID: PMC1295306]. <https://doi.org/10.1186/s12891-024-07552-5>.
- Nejati P, Lotfian S, Moezy A, Moezy A, Nejati M. The relationship of forward head posture and rounded shoulders with neck pain in Iranian office workers. *Med J Islam Repub Iran*. 2014;**28**:26. [PubMed ID: 25250268]. [PubMed Central ID: PMC4154278].
- O'Riordan C, Clifford A, Van De Ven P, Nelson J. Chronic neck pain and exercise interventions: frequency, intensity, time, and type principle. *Arch Phys Med Rehabil*. 2014;**95**(4):770-83. [PubMed ID: 24333741]. <https://doi.org/10.1016/j.apmr.2013.11.015>.
- Sepehri S, Sheikhhoseini R, Piri H, Sayyadi P. 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 Musculoskelet Disord*. 2024;**25**(1):105. [PubMed ID: 38302926]. [PubMed Central ID: PMC10832142]. <https://doi.org/10.1186/s12891-024-07224-4>.
- Berger AA, Liu Y, Mosel L, Champagne KA, Ruoff MT, Cornett EM, et al. Efficacy of Dry Needling and Acupuncture in the Treatment of Neck Pain. *Anesth Pain Med*. 2021;**11**(2). e113627. <https://doi.org/10.5812/aapm.113627>.
- Liaqat M, Arsalan A, Waqar M, Ahmad A, Gillani SA. Immediate and Prolonged Effects of Breathing Exercises on Pain, Quality of Life and Functional Disability in Patients of Upper Cross Syndrome: A Randomized Controlled Trial. *J Riphah Coll Rehabil Sci*. 2023;**11**(1):34-9. <https://doi.org/10.53389/jrcrs2023110108>.
- Gonzalez-Galvez N, Gea-Garcia GM, Marcos-Pardo PJ. Effects of exercise programs on kyphosis and lordosis angle: A systematic review and meta-analysis. *PLoS One*. 2019;**14**(4). e0216180. [PubMed ID: 31034509]. [PubMed Central ID: PMC6488071]. <https://doi.org/10.1371/journal.pone.0216180>.
- Warneke K, Lohmann LH, Wilke J. Effects of Stretching or Strengthening Exercise on Spinal and Lumbopelvic Posture: A Systematic Review with Meta-Analysis. *Sports Med Open*. 2024;**10**(1):65. [PubMed ID: 38834878]. [PubMed Central ID: PMC1150224]. <https://doi.org/10.1186/s40798-024-00733-5>.
- Khaledi A, Gheitsi M. Isometric vs Isotonic Core Stabilization Exercises to Improve Pain and Disability in Patients with Non-specific Chronic Low Back Pain: A Randomized Controlled Trial. *Anesth Pain Med*. 2024;**14**(1). e144046. [PubMed ID: 38725921]. [PubMed Central ID: PMC11078224]. <https://doi.org/10.5812/aapm-144046>.
- Borhany T, Shahid E, Siddique WA, Ali H. Musculoskeletal problems in frequent computer and internet users. *J Family Med Prim Care*. 2018;**7**(2):337-9. [PubMed ID: 30090774]. [PubMed Central ID: PMC6060916]. https://doi.org/10.4103/jfmpc.jfmpc_326_17.
- Khaledi A, Minoonejad H, Daneshmandi H, Akooshchian M, Gheitsi M. Schroth and Asymmetric Spinal Stabilization Exercises' Effectiveness on Back Pain and Trunk Muscle Endurance in Adolescents' Idiopathic Scoliosis: A Randomized Controlled Trial. *Med J Islam Repub Iran*. 2024;**38**:90. [PubMed ID: 39678764]. [PubMed Central ID: PMC11644102]. <https://doi.org/10.47176/mjiri.38.90>.
- Wagner DR, Tatsugawa K, Parker D, Young TA. Reliability and utility of a visual analog scale for the assessment of acute mountain sickness. *High Alt Med Biol*. 2007;**8**(1):27-31. [PubMed ID: 17394414]. <https://doi.org/10.1089/ham.2006.0814>.
- Montazeri A, Goshtasebi A, Vahdaninia M, Gandek B. The Short Form Health Survey (SF-36): translation and validation study of the Iranian version. *Qual Life Res*. 2005;**14**(3):875-82. [PubMed ID: 16022079]. <https://doi.org/10.1007/s11336-004-1014-5>.
- Mokhtaran S, Piri H, Sheikhhoseini R, Salsali M. Comparing two corrective exercise approaches for body image and upper-quadrant posture in schoolgirls with hyperkyphosis. *Sci Rep*. 2025;**15**(1):3882. [PubMed ID: 39890832]. [PubMed Central ID: PMC11785943]. <https://doi.org/10.1038/s41598-025-85665-0>.
- Yang J, Yang M, Lin Q, Fu J, Xi R. Effects of isometric training on the treatment of patients with neck pain: A meta-analysis. *Medicine (Baltimore)*. 2022;**101**(39). e30864. [PubMed ID: 36181068]. [PubMed Central ID: PMC9524965]. <https://doi.org/10.1097/MD.00000000000030864>.
- Bharti N, Ahmed H, Hasan S, Iqbal A, Uddin S, Ahamed WM, et al. Efficacy of Scapular Functional and Cervical Isometric Exercises in the Management of Chronic Mechanical Neck Pain: A Randomized Comparative Trial. *Pain Res Manag*. 2024;**2024**:5873384. [PubMed ID: 39734604]. [PubMed Central ID: PMC11671652]. <https://doi.org/10.1155/jprm/5873384>.
- Amjad M, Ur Rehman SS, Fatima G, Ikram M, Ghafoor S. Comparative effects of isometric and isotonic global neck muscles strengthening exercise programme on pain, range of motion, strength, function and quality of life in patients with chronic mechanical neck pain. *J Pak Med Assoc*. 2024;**74**(10):1843-6. [PubMed ID: 39407381]. <https://doi.org/10.47391/JPPMA.11378>.
- Kinsella R, Cowan SM, Watson L, Pizzari T. A comparison of isometric, isotonic concentric and isotonic eccentric exercises in the physiotherapy management of subacromial pain syndrome/rotator cuff tendinopathy: study protocol for a pilot randomised controlled trial. *Pilot Feasibility Stud*. 2017;**3**:45. [PubMed ID: 29163981]. [PubMed Central ID: PMC5684744]. <https://doi.org/10.1186/s40814-017-0190-3>.
- Rodrigues da Silva Barros B, Dal'Ava Augusto D, de Medeiros Neto JF, Michener LA, Silva RS, Sousa CO. Isometric versus isotonic exercise in individuals with rotator cuff tendinopathy-Effects on shoulder pain, functioning, muscle strength, and electromyographic activity: A protocol for randomized clinical trial. *PLoS One*. 2023;**18**(11).

- e0293457. [PubMed ID: 37956135]. [PubMed Central ID: PMC10642785]. <https://doi.org/10.1371/journal.pone.0293457>.
22. Fatima I, Mustafa M, Irfan Fazal M, Tariq A, Nadeem N, Nauman Jala M. Comparison of the Effectiveness of Isometric, Isotonic Eccentric And Isotonic Concentric Exercises in Pain and Strength Management of patients with Subacromial Impingement Syndrome - A Randomized Clinical Trial. *Pak J Med Health Sci*. 2021;**15**(11):2859-61. <https://doi.org/10.53350/pjmhs2115112859>.
 23. Kumar S, Singla D. Effect of exercise on posture, balance, gait, muscle strength, pulmonary function, and quality of life in hyperkyphotic older adults: a systematic review. *Sport Sci Health*. 2024;**20**(1):15-22. <https://doi.org/10.1007/s11332-023-01129-w>.
 24. Rostamizalani F, Ahanjan S, Rowshani S, BagherianDehkordi S, Fallah A. [Comparison of the Effects of Three Corrective Exercise Methods on the Quality of Life and Forward Head of men with Upper Cross Syndrome]. *J Paramed Sci Rehabil*. 2019;**8**(1):26-36. FA. <https://doi.org/10.22038/jpsr.2019.27480.1717>.
 25. Lederman E. *Functional Exercise Prescription: Supporting Rehabilitation in Movement and Sport*. East Lothian: Jessica Kingsley Publishers; 2022.
 26. Ekediegwu EC, Onwukike CV, Onyeso OK. Pain intensity, physical activity, quality of life, and disability in patients with mechanical low back pain: a cross-sectional study. *Bull Fac Phys Ther*. 2024;**29**(1):1. <https://doi.org/10.1186/s43161-023-00167-2>.