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Effect of Pilates exercise on balance and spinal curvature in subjects with upper cross syndrome: a randomized controlled clinical trial

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Abstract

Introduction. To investigate the outcomes of Pilates exercise compared to traditional treatment for the management of upper cross syndrome (UCS).
Methods. Forty female participants with UCS were randomly divided into two equal groups: group A (control group) and group B (experimental group). Both groups received two sessions per week for four consecutive weeks. Group A received a traditional physical therapy program consisting of stretching, strengthening, and postural correction exercises, while group B received a Pilates exercise program. Primary outcome measures were balance, spinal curvature, craniovertebral (CV) angle, and rounded shoulders, while the Neck Disability Index and Visual Analogue Scale served as secondary outcome measures. Measurements were recorded before and after treatment.
Results. A comparison of pre- and post-treatment test results showed that all dependent variables significantly improved for both groups ($p > 0.001$). However, Pilates exercise resulted in greater improvement in terms of balance, spinal curvature, CV angle, and pain ($p > 0.001$).
Conclusions. The Pilates exercise program proved more effective than the traditional physical therapy program in improving spinal curvature, balance, and function, and in reducing pain in UCS.
Key words: balance, Pilates exercise, upper cross syndrome, spinal curvature

Introduction

The most prevalent postural issue that results in joint dysfunction of the shoulder girdle and cervicothoracic region, especially at the atlantooccipital and glenohumeral joints, is known as upper cross syndrome (UCS) [1]. Naseer et al. [2] estimated that the prevalence of UCS was 32.43% among office employees, 24.32% among drivers, 27.03% among housewives, 16.22% among teachers, and 37.1% among medical students. Furthermore, Mubashir [3] reported an incidence of UCS ranging from 11% to 60% across various societies and age groups.

UCS is a widespread problem in workplaces and sometimes prevents workers from attending their scheduled shifts. In many countries, according to Ostergren et al. [4], work-related musculoskeletal injuries and complaints place a major strain on health, often resulting in lost workdays and high workers' compensation and disability costs. Nowadays, bad habits caused by technology, such as the overuse of mobile phones, televisions, computers, and tablets, have negatively impacted health. Abnormal postures while using these devices cause various mechanical loads on the neck and upper back, rounded shoulders from increased thoracic kyphosis, etc., leading to poor posture that can result in UCS [5].

Most jobs require prolonged use of forward arm positions in a dominant flexor synergy, such as physical therapists and computer operators [6]. The development of this postural syndrome has been linked to several variables, including work habits, proprioceptive inputs, and even psychogenic problems such as low self-esteem or despair [7]. Increased forward head angle and hyperextension of the upper part of the cervical spine, which are frequently associated with forward head posture, rounded shoulders, protracted scapulae, and thoracic kyphosis, are the two factors that induce UCS [8]. UCS is characterized by over-facilitation, tightness, or over-excitation of the pectoralis major and minor, subclavius, upper fibers of the trapezius, levator scapulae, sternocleidomastoid, and suboccipital muscles, and weakness or inhibition of the middle and lower fibers of the trapezius, rhomboids, serratus anterior, longus colli and capitis, infraspinatus, teres minor, and thoracic paraspinal muscles [9]. These muscle imbalances and movement disorders may directly impact the joint surfaces, potentially resulting in joint deterioration [10].

Breathing issues can occasionally occur with UCS due to the rib cage not being able to fully expand for lung inflation. The main muscles involved in breathing include the diaphragm, intercostals, scaleni, transverse abdominis, pelvic floor muscles, and deep intrinsic spinal muscles. Each of these muscles helps stabilize the spine and facilitate breathing. Therefore, decreased thoracic spine mobility and involvement of auxiliary respiratory muscles are the causes of respiratory dysfunctions in UCS [11]. As part of physical therapy for UCS, tight muscles are primarily stretched, weak and elongated muscles are strengthened, posture is adjusted, and manual therapy such as joint mobilization or myofascial release is used [12]. To our knowledge, five studies have reported on the role of physical therapy in UCS. Thacker et al. [13] used a variety of exercises and active release techniques to treat UCS, while Ali et al. [14] compared stretching exercises with muscle energy techniques for managing UCS. On the other hand, Rostamizalani et al. [15] examined the impact of three corrective exercise techniques on forward head posture and quality of life in males with UCS, and Arif et al. [16] employed traditional physical therapy to treat UCS, both with and with-

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out muscle energy approaches. Finally, to address cervical dysfunction in UCS [16], Gillani et al. [17] used an eccentric muscular energy approach versus static stretching activities. No studies have reported using Pilates exercise programs in managing UCS [17], although one study investigated the effect of Pilates on chronic nonspecific low back pain (LBP) by da Luz et al. [18] and on scoliosis by Kim et al. [19], finding significant effects of Pilates on both LBP and scoliosis.

Pilates exercise is a method that uses movements to stretch and strengthen certain muscles to condition the body and enhance posture, muscle tone, alignment, and flexibility [20, 21]. Pilates aims to strengthen, rebalance, and realign the body in conjunction with other workout regimens. It also focuses on improving individual body awareness, which further reduces the risks of strain or injury caused by imbalances. Pilates teaches individuals to identify their own musculoskeletal strengths and weaknesses and equips them with the knowledge to correct and rebalance their entire body mechanics [21]. The objective of this study was to investigate the outcomes of Pilates exercise compared to traditional treatments for managing UCS. The authors hope that this clinical trial will contribute to the treatment of UCS.

Subjects and methods

Design

This is a double-blind, randomized, controlled clinical experiment (assessment and patients) that investigated the effects of Pilates exercise compared to a traditional physical therapy program on UCS. Data were collected both before and after the treatment at two different times. The study was carried out between October 2022 and January 2023 at the outpatient clinic of the College of Physical Therapy. Both physical therapists who evaluated patients pre- and post-treatment remained blinded to the patients' allocation throughout the research. Additionally, by designating the groups with numbers, the statistician who carried out the outcome analysis was kept blind to the group allocation.

Participants

The College of Physical Therapy outpatient clinic recruited 70 female patients with UCS. Following a confirmed clinical medical diagnosis of UCS, their orthopedic doctor recommended they begin physical therapy. After physical therapy screening, 40 participants met the inclusion criteria, which were as follows: age 17 to 22 years, female gender, body mass index between 20–25 kg/m^2 [22], presence of excessive antero-posterior curvature of the thoracic/dorsal spine (Cobb angle for kyphosis) greater than 41° [23] using the spinal mouse device [24], CV angle of less than 50° [25], normal cognitive function, and willingness to participate in the study [12].

Sample size calculation was done using the balance index, as reported from a pilot study, with 80% power at $\alpha = 0.05$, 2 measurements, 2 groups, and an effect size of 0.47 using an *F*-test for repeated measures MANOVA within and between interactions. The minimum required sample size was 38 subjects, with an additional 4 (10%) subjects added for potential dropouts, resulting in a total sample size of 42 subjects (21 in each group). The sample size was calculated using G*Power software (version 3.0.10).

Participants were excluded if they had experienced any recent trauma (within three months of the initial consultation) [22], had a chief complaint of headaches or facial pain [26], had contraindications to Pilates exercises such as pregnancy, hypertension, osteoporosis, or spinal tumors [22], or had any structural abnormality in the upper and middle back (e.g., scoliosis or a positive Adam's test) [27]. Participants on anti-inflammatory or muscle relaxant medications underwent a three-day "washout" period before participating in the study [26].

After signing the consent form, demographic information was gathered, and 40 female participants were randomized into two equal groups: the control group (group A) and the experimental group (group B). Randomization was done by assigning an identification number to each participant by an independent researcher. Group A ($n = 20$) received a standard physical therapy program, including strengthening, stretch-

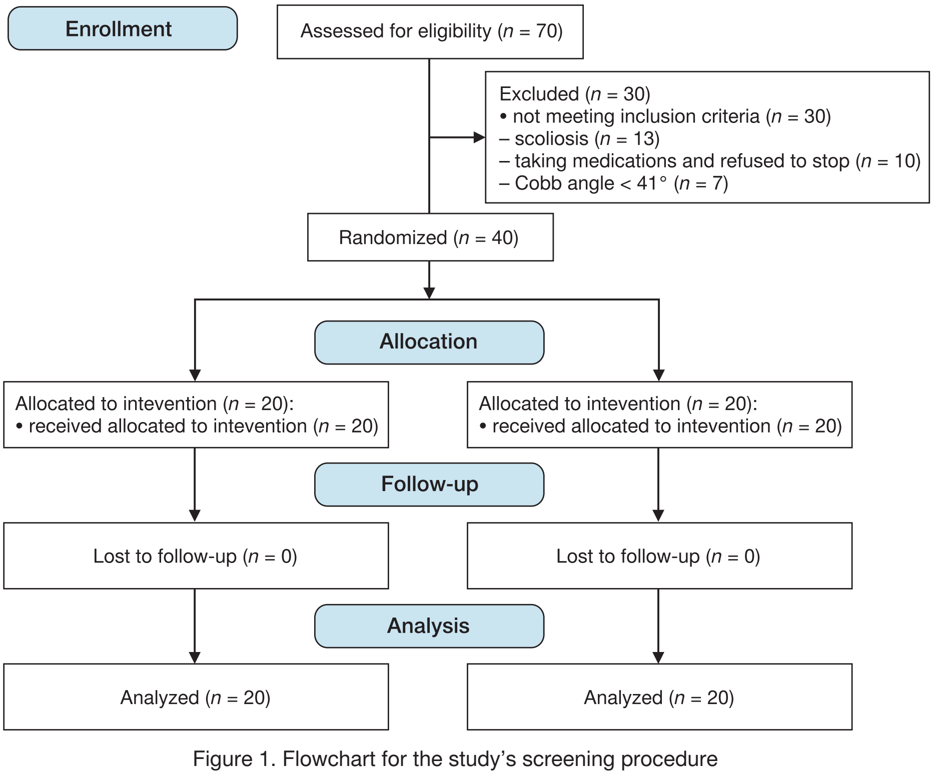

Figure 1. Flowchart for the study's screening procedure

ing, and postural correction exercises, while group B (*n* = 20) received Pilates exercises (Figure 1). There were no dropouts from the study; all participants completed the treatment program.

The pre- and post-treatment scores of outcome measures were examined by the same independent, experienced physical therapist who was not involved in the clinical trial. Both groups received two sessions per week for four consecutive weeks from another well-trained physical therapist. Each session lasted between 55 min and 1 h.

Treatment

Group A received stretching, strengthening, and postural correction exercises as follows [13]:

– Exercises for postural correction, stretching, and strengthening of the pectoralis major, levator scapulae, upper trapezius, serratus anterior, rhomboids, and deep neck flexors.

– The stretches included Brugger's, wall angels, sitting chair stretches, and doorway stretches. Each stretch was performed for 30 s on and 30 s off, three times per day.

– Push-ups and head-neck retraction were also included, with a total session time of about 60 min.

Group B received Pilates exercises. Each session lasted 60 min and included 10 to 12 exercises in the form of 10 steps, with no more than three repetitions of each exercise, as appropriate to each participant's ability. The exercises were performed independently by each participant. The following is a detailed description of each exercise utilized in both treatments, along with its starting and ending positions, number of repetitions, and accompanying pictures [28]:

1. Corrected neck alignment: While lying on the back on a mat (using pillows if needed), press the base of the cranium, triceps, back, and shoulder blades against the mat. Breathe while maintaining muscle contraction, as shown in Figure 2.

2. Arm circles: Perform arm circles in both directions on the mat, using strong ribcage breathing to engage the scapula, as shown in Figure 2.

3. Diamond press: Lie prone on a mat, using the lower part of the trapezius and serratus anterior muscles to slide the shoulder blades out and down. Move into slight back extension while maintaining this position, as shown in Figure 2.

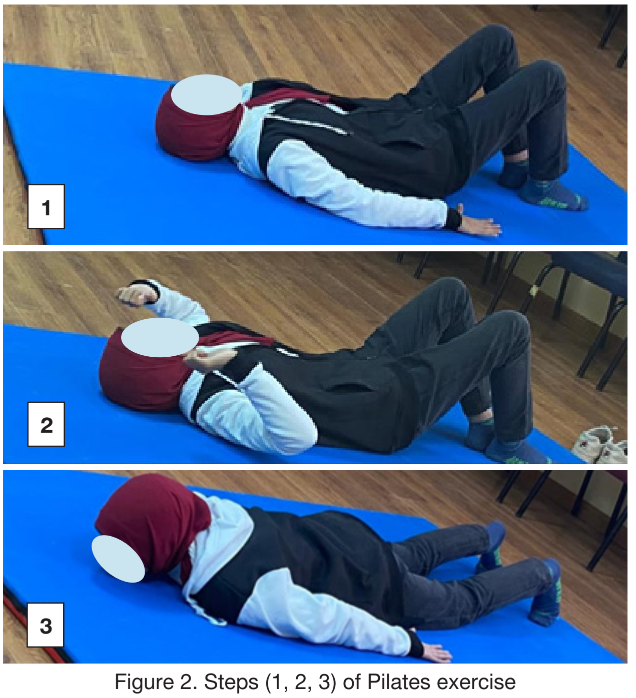

Figure 2. Steps (1, 2, 3) of Pilates exercise

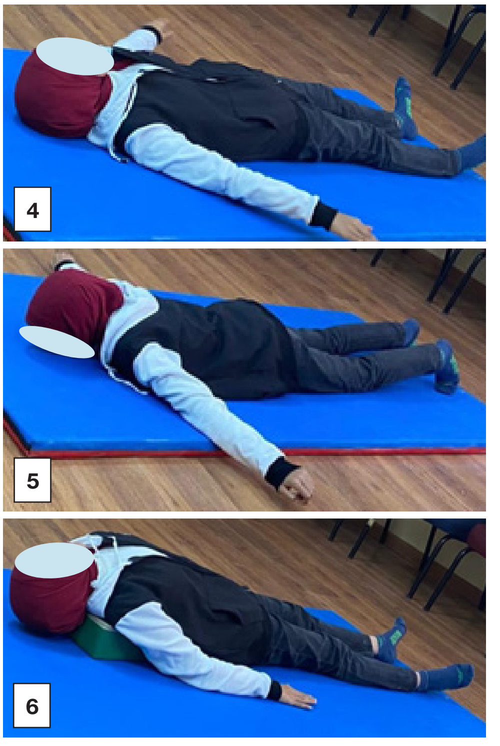

Figure 3. Steps (4, 5, 6) of Pilates exercise

4. Diamond press with lateral arm movement: Repeat the previous exercise but add lateral arm movement to the back extension, as shown in Figure 3.

5. Arm slides 90°: Lie supine on a mat with arms bent at 90° and thumbs on the floor. Slide elbows on the floor toward the waistline while contracting the serratus anterior muscle. Repeat with the other fingers. Always maintain proper neck alignment, as shown in Figure 3.

6. Arm circles on a tiny barrel: While lying on the back with the head and neck supported by the barrel, perform arm circles. Open the chest and link the scapula to the barrel while holding this position, as shown in Figure 3.

7. Chair expansion: Sit on the mat with your back to the chair. Expand the chest, stabilize the scapula, and place hands on a stepper while raising and lowering the arms.

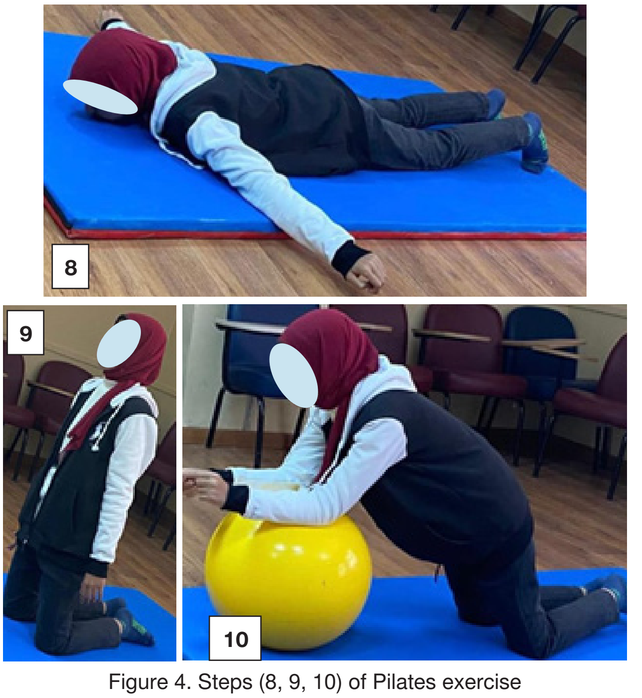

Figure 4. Steps (8, 9, 10) of Pilates exercise

8. Prone arm pumps: While lying prone, stabilize the scapula and pump the arms up and down with lower back support, as shown in Figure 4.

9. Straps for chest expansion: Kneel on the mat facing a wall with the chest open and upper back muscles engaged. Rotate the head 90° to the right and left repeatedly, as shown in Figure 4.

10. Kneel plank on a Swiss ball: Kneel on the mat and place the barrels on the ball in front of you. Adjust the position to meet plumb line requirements, keeping alignment while allowing the ball to move forward and fall diagonally. Use shoulder stabilizers to return to the starting position with proper alignment, as shown in Figure 4.

Outcomes measures

Primary outcome measures were spinal curvature, CV angle, rounded shoulder, and balance, while pain and functional impairment were considered secondary outcome measures.

Primary outcome measures

Spinal curvature using a spinal mouse device

The spinal mouse device (Idiag AG, Fehraltorf, Switzerland) is a tool that is physically guided along the skin of the spine and reconstructs the spine in the sagittal and frontal planes in both neutral and extreme positions. Actual measurements taken from subjects are used to create the photos. In the sagittal plane, the measurement positions are (a) standing straight; (b) full flexion; and (c) full extension. For research and patient monitoring in the clinic, the spinal mouse is a rapid, easy, reliable, and risk-free technique [29]. In the current study, the spinal mouse was used to measure spinal curvature. Before each use, baseline calibration was performed, and each participant's personal information was recorded. The thoracic kyphosis angle in the thoracic spine, measured from the standing position with the spine in erect, extension, and flexion positions, ranged from 41° to 44° [24]. The computer printed and recorded the test results. The average error from the three trials, as well as the value of each trial's error, were included [30].

Craniovertebral angle

The seventh cervical (C7) vertebra's spinous process and a second line connecting the spinous process of the C7 vertebra and the tragus of the ear together constitute the CV angle, which is one of the most objective ways to measure head posture [31]. The smartphone app Forward Head Posture can measure the craniovertebral angle in a standing position with validity and reliability, making it potentially helpful as an assessment tool [32]. In the current study, the CV angle was measured as follows: from a person's side, an imaginary horizontal line was marked at the C7 spinous process (e.g., located at the back of the vertebra at the base of each participant's neck). The CV angle is formed by the junction of a second line drawn from the C7 spinous process up to the tragus, which is the pointed region in front of the earhole. A forward head position is commonly defined as having a CV angle while standing less than 50°. An image snapped from the side was used to calculate this angle [33].

The rounded shoulder or sagittal shoulder posture

The rounded shoulder posture is measured by the angle created when a horizontal line through C7 crosses a line that runs between the posterior portion of the acromion and the midpoint of the larger tuberosity of the humerus. This angle serves as a reference for the forward position of the shoulder joint. There is clinical reliability and validity for this technique; a lower angle suggests that the shoulder is more forward in comparison to C7, indicating a more rounded shoulder [34]. The rounded shoulder test was developed to measure rounded shoulder posture. In a supine lying position, the therapist measured the distance from the shoulder joint to the plinth using tape measurement, with more than six cm indicating the presence of a rounded shoulder posture [35].

Balance evaluation using the Biodex Balance System

The Biodex Balance System (Biodex Medical Systems Inc., Shirley, NY, USA) is an advanced measuring and training tool for static and dynamic balance. It is considered a reliable and efficient tool. In the current study, the Biodex Balance System was used to measure the equilibrium (static and dynamic balance). Prior to each use, the device was calibrated, and each participant's personal information was recorded. The ability of participants to maintain the center of balance was highlighted by the Postural Stability Test. The patient's score on this test examined deviations from center, so a lower score is preferable to a higher score. Each participant stood on the platform with both lower extremities. There was a 20-s test period, using level of stability: 8 and position: two legs. The equipment recorded and printed the test's results, including the average error of the three trials as well as the value of each trial's error [30].

Secondary outcome measures

Visual Analogue Scale (VAS) to measure pain intensity

The VAS is a non-numerical pain scale that consists of a 100 mm (10 cm) horizontal line with 0 on the left side, indicating no pain and 10 on the right side, indicating the most intense pain that could be felt. In the study, each participant was asked to mark along the horizontal VAS line to indicate how much pain they were experiencing at that moment. Using a ruler, the distance in mm from the lower limit was calculated [36].

The Arabic Neck Disability Index (ANDI)

The ANDI is a 10-item questionnaire used to evaluate neck pain-related impairment. Six elements relate to activities of daily living (lifting, work, driving, recreation, personal care, reading), whereas four address subjective symptomatology (pain intensity, headache, concentration, and sleeping) [37]. Each item's score ranges from 0 (no pain and no functional limitation) to 5 (worst pain and maximum limitation), for a total score ranging from 0 (no disability) to 50 (totally disabled). A score of less than 4 indicates no disability, 5–14 indicates mild disability, 15–24 indicates moderate disability, 25–34 indicates severe disability, and scores greater than 35 indicate complete disability. It takes about 5–10 min to complete and grade the questionnaire, which is then converted to a percentage. No specific training is needed to administer it [38]. Each participant answered 10 questions on the questionnaire, with 6 options for each topic. Participants were instructed to select the response that best reflected their current situation [39].

Data analysis and statistical design

All data were examined for extreme scores, homogeneity of variance, and the normality assumption. The normality tests, Shapiro–Wilk and Kolmogorov–Smirnov, revealed that all measured variables had a normal distribution. In the current study, data were presented as mean and standard deviation (*SD*). To compare demographic information between participants in both groups, an unpaired *t*-test was utilized. Multivariate analysis of variance was used to compare all measured variables between and within groups. The Statistical Package for the Social Sciences (SPSS) software (version 20 for Windows; SPSS Inc., Chicago, Illinois, USA) was used for data analysis, with a *p*-value of 0.05 or less regarded as significant.

Results

Demographic data of patients

A total of 40 participants joined this study and were assigned to two equal groups at random (Table 1). The mean age of groups A and B was 19.2 ± 1.4 and 19.3 ± 1.5 years, respectively; height was 159.5 ± 5.7 and 160.3 ± 6.4 cm, respectively; and weight was 66.5 ± 6.3 and 67.4 ± 5.6 kg, respectively. The mean age, height, and weight of the two groups did not differ significantly ($p > 0.05$).

Table 1. Subjects' characteristics of both groups

Variables	Group A	Group B	*t*-value	*p*-value
Age (years)	19.2 ± 1.4	19.3 ± 1.5	–0.054	0.957
Height (cm)	159.5 ± 5.7	160.3 ± 6.4	–0.415	0.681
Weight (kg)	66.5 ± 6.3	67.4 ± 5.6	–0.422	0.675

Effect of Pilates exercise on spinal curvature

The mean ± *SD* of spinal curvature for participants in groups A and B pre-treatment was 45.9 ± 2.6 and 45.2 ± 2.2°, respectively, while post-treatment was 42.1 ± 2.7 and 35.1 ± 2.4°, respectively. There was no significant difference in the

Table 2. Comparison between pre- and post-treatment mean values of measured variables between and within groups

Variables	Group A mean ± *SD*	Group B mean ± *SD*	MD (95% CI)	*p*-value	ηp^2
Spinal curvature (degrees)					
pre-treatment (mean ± *SD*)	45.9 ± 2.6	45.2 ± 2.2	0.7 (0.858–2.25)	0.369	0.021
post-treatment (mean ± *SD*)	42.1 ± 2.7	35.1 ± 2.4	7 (8.62–5.3)	0.001*	0.666
p-value	0.001*	0.001*			
percentage change	8.3%	22.3%			
Craniovertebral angle (degrees)					
pre-treatment	42.5 ± 3.4	43.2 ± 3.7	0.75 (0.3–1.5)	0.509	0.012
post-treatment	38.4 ± 3.6	34.2 ± 3.3	4.15 (1.9–6.3)	0.001*	0.274
p-value	0.001*	0.001*			
percentage change	9.6%	21%			
Rounded shoulder (cm)					
pre-treatment	5.1 ± 0.5	5.2 ± 0.39	0.115 (0.414–0.18)	0.440	0.016
post-treatment	3.9 ± 0.55	4.1 ± 0.38	0.12 (0.423–0.183)	0.428	0.017
p-value	0.001*	0.001*			
percentage change	23.5%	21%			
Overall stability index					
pre-treatment	1.1 ± 0.2	1.07 ± 0.2	0.015 (0.119–0.149)	0.822	0.001
post-treatment	1.4 ± 0.25	1.7 ± 0.2	0.340 (0.847–0.193)	0.001*	0.356
p-value	0.001*	0.001*			
percentage change	27%	59%			
Visual Analogue Scale (mm)					
pre-treatment	7.4 ± 1	8 ± 1.1	0.55 (1.26–0.162)	0.126	0.061
post-treatment	4 ± 0.8	2.5 ± 1.2	1.4 (0.802–2.098)	0.001*	0.351
p-value	0.001*	0.001*			
percentage change	46%	68.7%			
Neck Disability Index					
pre-treatment	46.8 ± 7.7	51.3 ± 6.8	4.5 (9.1–0.146)	0.057	0.092
post-treatment	16.8 ± 3.6	15.2 ± 4.6	1.65 (1.013–4.3)	0.217	0.040
p-value	0.001*	0.001*			
percentage change	64.1%	70.4%			

ηp^2 – partial eta square MD – mean difference, CI – confidence interval, * significant pre-treatment mean values of spinal curvature between the two groups (p = 0.369). However, group B showed significant improvement post-treatment (p = 0.001). Within both groups, there was a significant difference between the pre- and post-treatment means of spinal curvature (p = 0.001). Groups A and B experienced percentage changes in pre- and post-treatment mean values of 8.3% and 22.3%, respectively, as shown in Table 2.

Effect of Pilates exercise on CV angle

The mean ± *SD* of CV angle for participants in groups A and B pre-treatment was 42.5 ± 3.4 and 43.2 ± 3.7°, respectively, while post-treatment was 38.4 ± 3.6 and 34.2 ± 3.3°, respectively. There was no significant difference in pre-treatment mean values of CV angle between the two groups (p = 0.509). However, there was a significant difference post-treatment in favor of group B (p = 0.001). There was a significant difference between the pre- and post-treatment mean values of CV angle within both groups (p = 0.001). Groups A and B experienced percentage changes between pre- and post-treatment mean values of 9.6% and 21%, respectively (Table 2).

Effect of Pilates exercise on rounded shoulders

The mean ± *SD* of rounded shoulders for participants in groups A and B pre-treatment was 5.1 ± 0.5 and 5.2 ± 0.39 cm, respectively, while post-treatment was 3.9 ± 0.55 and 4.1 ± 0.38 cm, respectively. The pre-treatment and post-treatment mean values of rounded shoulders did not differ significantly between the two groups (p = 0.440 and p = 0.428, respectively). However, there was a significant difference between pre- and post-treatment values in groups A and B (p = 0.001), with percentage changes of 23.5% and 21%, respectively (Table 2).

Effect of Pilates exercise on balance

The mean ± *SD* of the overall stability index for participants in groups A and B pre-treatment was 1.1 ± 0.2 and 1.07 ± 0.2, respectively, while post-treatment was 1.4 ± 0.25 and 1.7 ± 0.2, respectively. The pre-treatment mean values did not differ significantly between the two groups (p = 0.822). However, group B showed significant improvement post-treatment (p = 0.001). There was a significant difference between the pre- and post-treatment mean values within both groups (p = 0.001). Groups A and B experienced percentage changes in pre- and post-treatment mean values of 27% and 59%, respectively (Table 2).

Effect of Pilates exercise on pain

The mean ± *SD* of pain for participants in groups A and B pre-treatment was 7.4 ± 1 and 8 ± 1.1 mm, respectively, while post-treatment was 4 ± 0.8 and 2.5 ± 1.2 mm, respectively. The pre-treatment mean values did not differ significantly between the two groups (p = 0.126). However, group B showed significant improvement post-treatment (p = 0.001). There was a significant difference between the pre- and post-treatment mean pain levels within both groups (p = 0.001). Between pre- and post-treatment mean values, group A and group B experienced percentage changes of 46% and 68.7%, respectively (Table 2).

Effect of Pilates exercise on Neck Disability Index

The mean ± *SD* of ANDI for participants in groups A and B pre-treatment was 46.8 ± 7.7 and 51.3 ± 6.8, respectively, while post-treatment was 16.8 ± 3.6 and 15.2 ± 4.6, respectively. The pre- and post-treatment mean values for both groups did not differ significantly (p = 0.057 and p = 0.217, respectively). However, there was a significant difference between pre- and post-treatment ANDI values within both groups (p = 0.001). Groups A and B experienced percentage changes of 64.1% and 70.4% between pre- and post-treatment mean values, respectively (Table 2).

Discussion

The effects of a Pilates exercise program on spine curvature, rounded shoulders, balance, pain, and neck-specific impairment in patients with UCS were the subject of the current study, which, to the authors' knowledge, is the first study evaluating the effects of Pilates on UCS. The present study's findings point to improvements in both the control and Pilates groups in all measured parameters; however, the Pilates group showed a greater improvement. These preliminary findings suggest that the use of Pilates exercise in the management of UCS may contribute to more positive outcomes in terms of spine curvature, balance, pain relief, and functional impairment.

The traditional treatment program, consisting of postural correction, stretching, and strengthening exercises, was effective in improving the function of muscles of the shoulders, chest, and upper back and had an impact on spinal alignment in UCS. When muscles are tight, it can lead to joint dysfunction, spinal malalignment, and pain. Additionally, muscle tightness usually occurs asymmetrically, so stretching can help prevent this problem to promote good spinal health and improve and maintain flexibility, which then minimizes the occurrence of any injury [13]. These findings are in line with those of Bayattork et al. [40], who suggested assessing the efficiency of a thorough corrective exercise program on muscle alignment, particular muscle activations, and relevant movement patterns in men with UCS. Their study provided new insights into how exercise affects alignment as well as vital outcomes such as muscle activation and movement patterns [40]. Also, Thacker et al. [13] studied the effects of alternative techniques (active release techniques and exercises) on UCS, which proved effective, but comparing it with the results of the current study may be inaccurate because the treatment modalities are different.

The Pilates method is one of the current approaches used to promote muscle recovery, as it works the body by using gravity and springs to increase resistance and help with the execution of each movement. Thus, it may be more effective in the treatment of UCS [41]. This technique, which was established by Joseph Pilates, uses exercises to promote body–mind harmony based on several principles, including centering, control, precision, fluidity of movements, concentration, and breathing [42].

The current study's findings are consistent with prior Pilates research, such as the one by da Luz et al. [18], who found that, after six weeks of follow-up, a Pilates exercise program was superior to alternative therapies in the treatment of chronic LBP.

In individuals with idiopathic scoliosis, Kim et al. [19] examined the effects of Schroth and Pilates workouts on the Cobb angle and body weight distribution. For 12 weeks, one group did Schroth exercises three times a week, while the other did

Pilates exercises. The results indicated that Schroth and Pilates exercises might change the Cobb angle and weight distribution in patients; however, an intergroup comparison revealed that Schroth exercise was superior to Pilates exercise.

The effectiveness of the Pilates technique as a therapeutic modality was established by de Araujo et al. [43], who evaluated the effects of Pilates exercise on chronic mechanical neck pain. There were improvements in pain, function, quality of life, and a decrease in the use of analgesics. For 12 weeks, patients in the Pilates group participated in two sessions a week of Pilates.

Limitations

The results of this study were constrained by its preliminary nature and the small number of participants. The demographic representation in each group did not necessarily correspond to that of the general population (e.g., sex, age). Additionally, the current study recruited only females and did not include follow-up. Therefore, the results cannot be generalized to the entire population, although they provide a starting point. To verify and assess our findings, larger and more extensive research is required.

Conclusions

This study provides preliminary evidence that a traditional treatment program consisting of stretching exercises, strengthening, and postural correction was effective in UCS. However, the Pilates exercise program proved more effective in terms of spinal curvature, craniovertebral angle, rounded shoulders, balance, pain, and neck-specific disability level.

Acknowledgment

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Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the ethical committee of the College of Physical Therapy, Cairo University (approval No.: P.T.REC/012/003992). Clinical Trials registration number: NCT05591729.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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