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Title: Effects of the Eight Weeks of Corrective Exercises with Music and with Laughter Therapy on Upper Crossed Syndrome and Related Electrical Activities in Female Employees

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Abstract

Purpose: Building upon the current gaps in rehabilitation paradigms, this study aims to comprehensively compare the therapeutic efficacy of a targeted corrective exercise program integrated with music versus one combined with laughter therapy. Specifically, this trial investigates their distinct impacts on postural malalignments associated with Upper Crossed Syndrome (UCS) and the neuromuscular adaptations quantified via surface electromyographic (sEMG) activity of key synergists and antagonists implicated in cervicoscapular dyskinesis.

Methods:

This quasi-experimental study involved 36 female employees aged 30–40 years diagnosed with UCS. Participants were selected through purposive and convenience sampling and were randomly allocated into two equal-sized experimental groups: Group 1 (Corrective Exercises with Music) with a mean age of 34.24 years, and Group 2 (Corrective Exercises with Laughter Therapy) with a mean age of 35.72 years. Both groups engaged in their respective exercise protocols for eight weeks, with three sessions per week. Forward Head Posture angle, Rounded Shoulder Angle, and kyphosis severity were assessed using photographic methods. Muscle electrical activity of the sternocleidomastoid, trapezius, pectoralis major, serratus anterior, and latissimus dorsi was measured via sEMG. Data were analyzed using a repeated-measures Analysis of Variance (ANOVA) at a significance level of $P \leq 0.05$. All analyses were performed using SPSS software, version 27.

Results: Both music-based and laughter-based corrective training groups demonstrated significant improvements in kyphosis, forward head and shoulder angles, and muscle electrical activity compared to baseline ($P<0.05$). However, between-group analysis revealed that a significant difference was observed solely in the kyphosis variable ($P<0.001$).

Discussion: While both music-augmented and laughter-enhanced corrective exercise protocols yielded significant intra-group improvements in postural alignment and EMG parameters, the lack of a standalone corrective exercise control group precludes the determination of the specific additive effects of these auditory modalities. Consequently, it remains unclear whether the observed improvements were uniquely attributable to the music or laughter, or simply a reflection of the corrective exercises themselves.

Keywords: Corrective exercises, music therapy, laughter therapy, Upper Crossed Syndrome, electromyography

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Highlights

- Both interventions (music and laughter therapy) were associated with significant within-group improvements in forward head angle, rounded shoulder angle, and kyphosis, as well as changes in electromyographic muscle activity.
- Both combined interventions represent potentially engaging approaches to delivering corrective exercise.
- Implementing such combined interventions is expected to enhance participant motivation.

Plain Language Summary

This study investigated whether combining corrective exercises aimed at managing postural abnormalities associated with Upper Crossed Syndrome (UCS) with music or laughter therapy affects postural and neuromuscular outcomes. The results demonstrated that female employees with UCS who performed corrective exercises alongside either music or laughter therapy showed significant within-group improvements in postural measures and muscle electrical activity. A significant between-group difference was observed for kyphosis, whereas no significant between-group differences were found for forward head angle, rounded shoulder angle, or the assessed EMG variables. These findings suggest that music and laughter may be considered engaging adjunctive components of corrective exercise programs for sedentary office workers; however, their additional benefit beyond corrective exercise alone cannot be determined because an exercise-only control group was not included.

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Introduction

Upper Crossed Syndrome (UCS), characterized by a specific pattern of muscular imbalance in the cranial and shoulder regions, is primarily driven by physical inactivity and suboptimal postural habits (1). This syndrome manifests through postural abnormalities, including kyphosis, forward head posture, and protracted shoulders (1, 2, 3). Pathophysiologically, UCS stems from a loss of neuromuscular coordination among the deep neck flexors and lower scapular stabilizers, coupled with dysfunction in the trapezius, levator scapulae, and pectoralis major and minor muscles. Rooted in chronic muscular imbalances, this disorder precipitates persistent alterations in posture and muscle function, potentially leading to pain, restricted range of motion, and impaired upper-limb performance. Extensive research has validated the efficacy of corrective interventions in managing UCS. For instance, Hajizadeh et al. (2021) demonstrated the positive effects of a targeted corrective exercise protocol on postural alignment in wushu athletes. Similarly, Abdolzadeh and Doshmadi (2019) confirmed that an eight-week corrective exercise program based on NASM principles significantly improved postural outcomes. Furthermore, Bae et al. highlighted that a combination of middle/lower trapezius strengthening and levator scapulae/upper trapezius stretching is effective in mitigating the syndrome (4, 5, 6). Given that the etiology of UCS is fundamentally linked to muscular imbalance, electromyographic (EMG) analysis is essential to achieve a precise understanding of altered muscle activation patterns and the subsequent restoration of neuromuscular function. EMG signal analysis facilitates the assessment of muscle activity levels and intermuscular coordination (7), providing critical insights into the physiological mechanisms underlying the efficacy of corrective exercises.

Beyond physical interventions, emerging research has explored the holistic health benefits of auditory and psychological stimuli, such as music and laughter. Regarding music therapy, Stanhope et al. (2020) demonstrated the therapeutic benefits of singing bowl music (8), while

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MacLean et al. (2014) reported that rhythmic music can enhance gait stability in healthy older adults (9). In the realm of laughter therapy, Zarandi et al. (2016) observed positive clinical outcomes, and subsequent studies by Tanaka et al. (2018) and Mousavi et al. (2018) further corroborated the positive effects of laughter therapy on adult populations (10, 11).

Music possesses a profound, cross-cultural heritage (12). Historically, music therapy has been employed by seminal figures such as Pythagoras, Aristotle, and Hippocrates, maintaining a continuous role in therapeutic practices throughout history (13). Parallel to this, laughter therapy has emerged as a potent non-pharmacological, alternative intervention with documented benefits for mental health and immune function. A key advantage of laughter therapy is its high accessibility and widespread acceptability, as it requires no specialized facilities or equipment. Consequently, the medical community has increasingly sought to integrate laughter therapy into conventional treatment protocols (14). Despite the established efficacy of corrective exercises in mitigating the postural abnormalities associated with UCS, the potential for synergistic effects through adjunctive interventions remains under-explored. Specifically, it is not yet clear whether integrating distinct psychological or sensory modalities such as music or laughter into a corrective exercise framework can elicit divergent postural or neuromuscular responses. To date, the comparative influence of music versus laughter therapy as adjuncts to corrective exercise has not been adequately investigated in individuals suffering from UCS.

Therefore, the present study aims to compare the effects of an eight-week intervention consisting of corrective exercises combined with music therapy versus corrective exercises combined with laughter therapy on postural alignment and the EMG activity of key muscles implicated in UCS. The novelty of this research lies in the direct comparison of these two adjunctive approaches within a standardized corrective exercise framework, thereby

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elucidating whether the specific type of adjunct modulates postural correction and neuromuscular activation patterns.

Methods

Study design and Participants

This study is practical and semi-experimental, using a pretest–posttest design. After the proposal was approved by the Specialized Review Board of the Sports Injuries and Corrective Eexercise Group at Ferdowsi University of Mashhad, Iran, a total of 36 employed women diagnosed with UCS were recruited purposively and conveniently. Participants were between 30 and 40 years old, with a body mass index (BMI) ranging from 18 to 25 kg/m^2.

The participants were randomly assigned to two groups: corrective exercises with laughter and corrective exercises with music. All muscle activity assessments were performed on the participants dominant side, which was the right side for all participants. The sample size was calculated using G*Power software (version 3.1.9.2), based on an expected primary outcome of forward head angle, with an estimated effect size (f) of 0.43 derived from previous literature on corrective exercise interventions for UCS, an alpha level of 0.05, and a statistical power $(1-\beta)$ of 0.80. The calculation was performed for a repeated-measures ANOVA with two groups and two measurement time points, assuming a correlation of 0.50 between repeated measurements. A 20% potential dropout rate was also considered. Although a 20% dropout rate was anticipated during the sample size calculation, no participants withdrew from the study during the intervention. Therefore, all 36 participants (18 per group) completed the study and were included in the final analysis (15). The research steps can be seen in Figure 1.

Before the study began, all participants signed an informed consent form approved by the Research Ethics Committee of Ferdowsi University of Mashhad (IR.UM.REC.1401.100). This research was conducted in accordance with the ethical standards set out in the Declaration of Helsinki.

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Inclusion and Exclusion criteria

The participants were employed women working in administrative roles with at least 3 years of work experience. All subjects worked with a computer for at least 4 hours per day. Their body mass index (BMI) ranged between 18 and 25. They had a forward head angle of 44 degrees, rounded shoulders greater than 49 degrees, and kyphosis of 42 degrees (11). None of the participants had a history of fractures, surgery, or joint diseases of the spine. Furthermore, none had any cardiac or respiratory disorders. The subjects had normal hearing (0 to 25 dB). They had experience listening to music and were cooperative during laughter. No participant had scoliosis of the spine or any abnormalities in the pelvis or lower limbs. In addition, the subjects had no pathological pain in the neck or upper extremities. According to the questionnaire, none of them had performed any effective physical activity within the previous 2 months, and none had received clinical intervention within the past year.

Randomization

The randomization process was carried out using sealed envelopes in which papers with the numbers 1 and 2 were placed inside the envelopes. Number 1 corresponded to the music group and number 2 corresponded to the laughter group. Each participant selected one sealed envelope and was assigned to the corresponding group. Participants in each group were unaware of the conditions of the participants in the other group (16).

Rehabilitation interventions

The training protocol was designed according to NASM principles, incorporating inhibition, lengthening, activation, and integration techniques (4). The training program spanned eight weeks, with three sessions per week, each lasting 60 minutes, conducted under the supervision of the tester. The rest period between sets was set between 30 to 45 seconds, adjusted proportionally to the duration of each set. Exercises progressed from simple to complex, and to increase training intensity, the principle of overload was applied by increasing resistance

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and the number of exercises and sets. Each training session included a warm-up (5 to 10 minutes), a strengthening and stretching program (40–50 minutes), and a cool-down (5–10 minutes). Participants performed the exercises in a circuit training format. In the corrective exercise group with laughter therapy, participants performed breathing exercises, inhibition and lengthening techniques, closed-mouth laughter, and in the activation phase, hearty laughter, silent open-mouth laughter, and undulating laughter during the rest intervals between movement sets, following the NASM guidelines (2-2-4). In the corrective exercise group with music, after explaining the exercise, the selected music was played, and participants performed the exercises while listening to the rhythm of the music and focusing on executing the movements according to the aforementioned NASM guidelines (2-2-4). Relaxing music was used for stretching and release exercises, while rhythmic music was used for isotonic and strengthening exercises. Generally, for this research, instrumental music without lyrics was chosen. This musical genre minimizes potential effects of vocals on the listener, thereby increasing their ability to focus on the intended activity. The selected music pieces were primarily chosen based on the required tempos for the research, drawing from various styles and aligning with the intended movements. The selected pieces were popular instrumental tracks and offered variety. The differences among the chosen pieces lay in their tempo, instrumentation, and emotional expression, which were relevant to the different stages of the research exercises.

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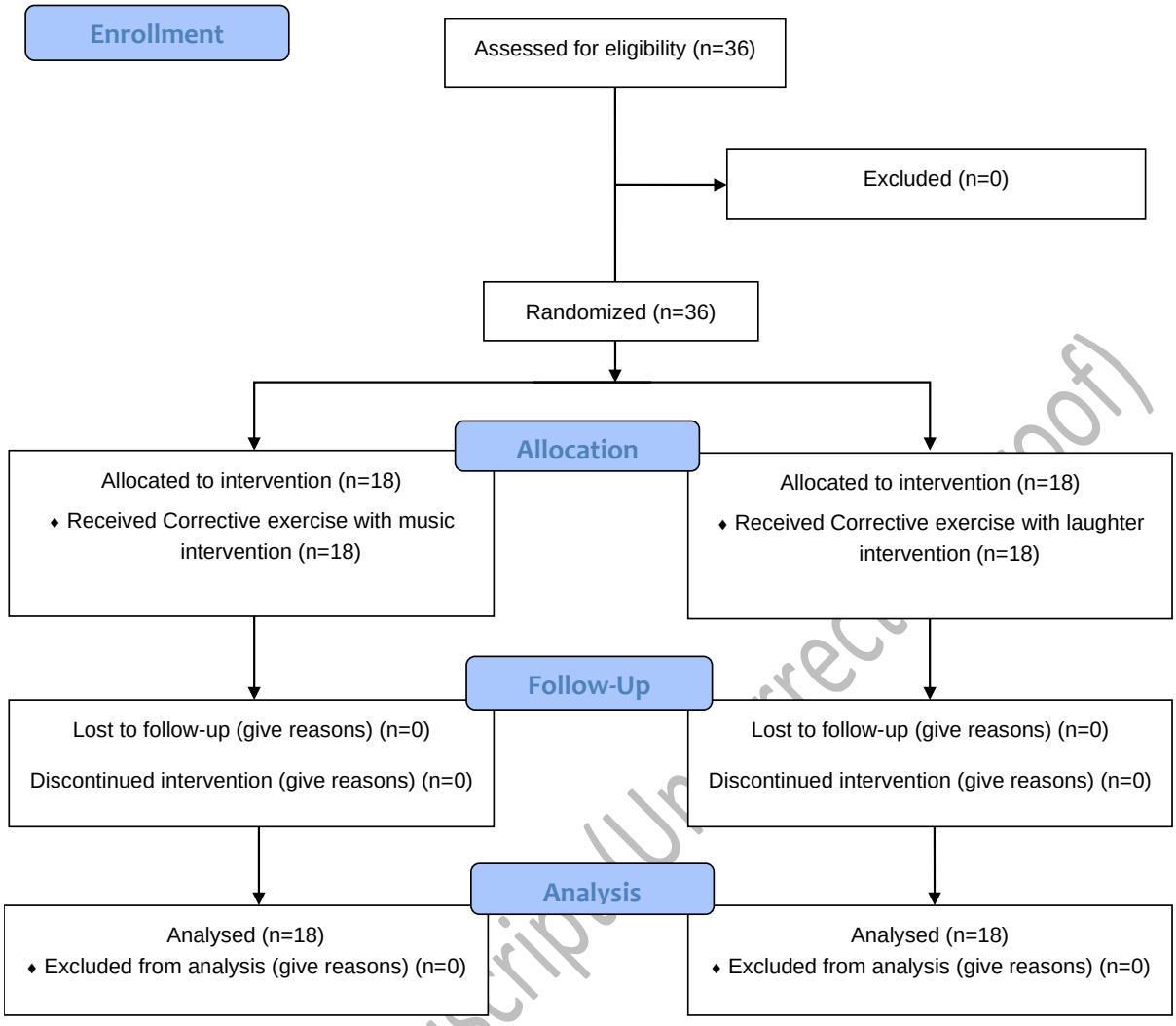


Figure 1. Diagram of participant progression.

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Measuring Forward Head Angle and Rounded Shoulders

Using lateral views, three anatomical points were first identified and marked with a marker: the earlobe, the acromion process, and the spinous process of the seventh cervical vertebra (C_7). Then, the participant was asked to stand against a wall at a designated spot, with the arm opposite the marked side facing the wall. A camera was set up at shoulder height, perpendicular to the ground, and at an appropriate distance of approximately 265 cm from the participant to take the photo (17, 18). Before the photo was taken, the participant was instructed to raise their hands three times, bend forward three times, and then stand naturally and comfortably. A photo was taken five seconds after the participant relaxed (17, 18, 19). The images were transferred

to a computer, and using AutoCAD software, the forward head angle and rounded shoulder angle were calculated. The forward head angle was determined by measuring the angle between the tragus of the ear and the C_7 vertebra relative to the vertical line, while the shoulder angle was defined by the line connecting C_7 and the acromion process relative to the vertical line (20)

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Measuring Kyphosis Angle

First, the participant was asked to stand naturally without upper body clothing or shoes, with weight evenly distributed between both feet. The examiner then identified the spinous processes of the second and the twelfth thoracic vertebrae. To locate the T_2 vertebra, the examiner placed the middle and index fingers on the sixth and seventh cervical vertebrae. The participant was asked to bend their neck forward and then perform neck extension. During extension, the spinous process of T_6 disappeared beneath the finger, leaving the prominent spinous process of T_7 visible. The T_2 vertebra was then identified by counting downward from the known point of T_7 (21).

To locate T_{12}, the participant was asked to place their hands on the edge of a table and lean forward, shifting their weight onto their hands. Since the spinous process of T_{12} aligns horizontally with the lower edge of the twelfth ribs, both ribs were simultaneously touched at their lower borders, and their paths inward and upward were followed until they disappeared into soft tissue. At this point, a straight line was drawn from the fingertips to estimate the position of the T_{12} spinous process. If there was doubt, the examiner asked the participant to bend and straighten their trunk while the examiner, with two fingers placed between the vertebrae, felt for the proper connection point of the thoracic and lumbar vertebrae before marking the spot. To minimize measurement error related to skin movement, the examiner held their finger on the prominence until the participant returned to standing position, then marked the point (21).

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To measure the kyphosis angle, after locating T_2 and T_{12}, the examiner placed a flexible ruler between these points along the spinal column and traced its curve onto paper without changing its position. The depth of the most prominent part of the curve (H) and the straight line connecting its two endpoints (L) were recorded, then inserted into the formula: 4arctan 2HL, which calculated the kyphosis angle. The validity and reliability of the flexible ruler were reported as 0.91 and 0.82, respectively (22).

Electrical activity of muscles

Electromyographic activity was recorded using a 16-channel Biovision electromyography system. To provide a clear representation of the electromyographic data and to enable comparison and interpretation of differences, the mean EMG values of three repetitions during muscle contraction against resistance were compared between the two groups. After each test trial, participants rested for 5 seconds in a neutral anatomical position (7).

Measuring Electrical Activity of the Sternocleidomastoid Muscle

To measure the electrical activity of the sternocleidomastoid muscle, the examiner first palpated the muscle belly on the anterior-lateral side of the neck. Next, two active electrodes were placed 2 cm apart directly over the muscle belly, aligned parallel to the muscle fiber direction. The electrodes were positioned approximately at the midpoint between the mastoid process and the sternal notch (23, 24) . To record maximal isometric contraction of the muscle, the participant was asked to perform neck flexion combined with rotation toward the opposite side against resistance.

Measurement of Upper Trapezius Muscle Electrical Activity

The participant sat upright with their arms hanging naturally at their sides. To measure the electrical activity of the upper trapezius muscle, electrodes were placed on the belly of the muscle at an angle between the neck and the shoulder, aligned with the muscle fibers. The electrodes were positioned at a distance of half the line between the Tuberomarginale process

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and the C_7 vertebra. To record the maximum voluntary isometric contraction (MVIC), the participant lifted their shoulder, extended their head, and turned their head and neck toward the elevated shoulder, with the face turned away from it. Resistance was applied downward and opposite to the lateral anterior flexion (25).

Measurement of Middle Trapezius Electrical Activity

The participant sat upright with arms relaxed at their sides. An electrode was placed vertically between the medial border of the scapula and the thoracic spine at the T3 level. To record the maximum voluntary isometric contraction, the participant was asked to lie face down, keep their shoulder in a horizontal abduction position with external rotation, and produce maximum muscle contraction against resistance (25).

Measurement of Lower Trapezius Electrical Activity

The participant sat upright with arms hanging at their sides. An electrode was placed obliquely upwards and outwards, two-thirds of the way along the line connecting the root of the scapular spine to the eighth thoracic vertebra. To record the maximum voluntary isometric contraction of the lower trapezius, the participant lay face down and raised their arm in line with the fibers of the lower trapezius above the head, with resistance applied above the elbow (25).

Measurement of Pectoralis Major Electrical Activity

For this, two active electrodes were placed 2 cm apart on the chest, approximately 2 cm below the clavicle and aligned along its longitudinal axis. To record the maximum isometric contraction of the muscle, the examiner applied resistance during shoulder flexion and abduction movements up to 30 degrees, while the participant performed these movements. Likewise, to measure the electrical activity of the sternal part of the pectoralis major, the participant internally rotated their arm against resistance, and the examiner touched the infraclavicular fold and placed two active electrodes 2 cm apart horizontally on the muscle mass of the chest, about 2 cm below the armpit (26).

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Measurement of Serratus Anterior Activity

To measure the electrical activity of the Serratus Anterior, the arm was flexed to 90 degrees. Electrodes were placed along the midline beneath the armpit at the level of ribs 6-8. To record the maximum voluntary isometric contraction of the anterior deltoid, the participant sat unsupported with their back straight, positioned the arm at 125 degrees of flexion, and performed flexion and upward rotation of the shoulder against resistance (14, 26).

Measurement of Latissimus Dorsi Activity

For this, electrodes were placed about 1 cm below the inferior angle of the scapula and halfway between the spine and the lateral edge of the torso, in an oblique position. To record the maximum voluntary isometric contraction, the participant lay face down with the arm resting at their side and the shoulder internally rotated. They performed arm extension against resistance applied above the arm, while pressure was exerted on the hip on the opposite side (14, 26).

Data analysis

Electromyographic signals, after being normalized from 0 to 100% over the desired time interval, were analyzed and converted into usable data using MATLAB 2018A (The MathWorks, Inc., Natick, MA, USA) (27).

The analysis and processing of data obtained from raw EMG signals can be performed in three domains: time, force, and fatigue. In this study, the data were examined with an emphasis on the time domain. Considering that, at all stages of signal recording, the main sources of variability were the software and the participants, the following points were taken into account: During data recording and test execution, if any disturbance was observed in the EMG signals, the test was stopped and, after a short rest interval, repeated again. At the end of each test stage, during a 1-minute rest interval, the raw signals were checked for the presence of noise. If, during testing, a participant experienced pain or severe fatigue such that they could not resume

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the test or lacked sufficient motivation to continue, they were allowed to stop the test and withdraw from the study. The signal amplifier in the EMG device automatically amplified the signals, and a band-pass filter with a low cutoff frequency of 10 Hz and a high cutoff frequency of 500 Hz was applied to the signals. The RMS value was calculated, and the signal amplitude was normalized relative to its maximum. The area under the curve was calculated as an index for comparing participants from time t_0 (start of movement) to time t_1 (end of movement). To provide a clear representation of the EMG data and to facilitate comparison and interpretation of differences, the mean EMG values obtained before the start of the training protocol were considered as the baseline reference (100%). Then, the mean values obtained after the training period, with and without music, were reported. All steps of signal normalization were performed using proprietary software called Simi Motion associated with the device. The data were then analyzed and converted into usable values using MATLAB. Since the EMG signals corresponding to the onset and termination of movement were mostly contained within approximately the first and last one second of each waveform, the middle three seconds of each MVC contraction waveform were selected for analysis.

Statistical analysis

For data description in this study, measures of central tendency and dispersion were used. All statistical operations were performed using SPSS software (Version 22). The Shapiro-Wilk test was used to assess the normality of data distribution, and the Levene`s test was employed to examine the homogeneity of variance within groups. A repeated-measures ANOVA was also used for intra- and inter-group comparisons. A significance level of ($p < 0.05$) was considered.

Result

The results of this study are presented in 3 sections. The results of the current study showed a significant difference between the two groups of corrective exercises with and without music regarding the kyphosis angle (P=0.001). However, no difference was observed in the forward

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head angle, rounded shoulder, and electrical activity of the following muscles between the two groups: sternocleidomastoid, upper trapezius, middle trapezius, lower trapezius, pectoralis major, serratus anterior, and latissimus dorsi. Also, in within-group assessments, both groups (corrective exercises with music and without music) showed significant changes in the kyphosis angle, forward head, rounded shoulder, and electrical activity of the sternocleidomastoid, upper, middle, and lower trapezius, pectoralis major, serratus anterior, and latissimus dorsi muscles.

Individuals characteristics

In the descriptive findings section of the study, the results related to the mean and standard deviation of the subjects' individual characteristics are presented in Table 1.

Table 1 Demographic characteristics of the groups (Mean±SD)

Variable	Group	X ± SD	P-value
Age (Years)	Music	34.24 ± 3.24	0.22
	laughe	35.72 ± 3.91	
Weight (KG)	Music	60.48 ± 6.09	0.60
	laughe	61.47 ± 5.14	
Hight (M)	Music	162.0 ± 3.95	0.45
	laughe	161.0 ± 3.95	
BMI ($KG/M^{2)}$	Music	23.55 ± 1.78	0.55
	laughe	23.85 ± 1.15	

Significance at the level of p <0.05, p: between group.

Comparison of Kyphosis, Forward Head, and Round Shoulder

The mean difference between the pre-test and post-test in the kyphosis variable in the music group was -13 and -5.8 in the laughter group. In the forward head angle, the difference between the pre-test and post-test in the music group was -9.4 and -8.68 in the laughter group, and in

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the round shoulder, the difference between the pre-test and post-test in the music group was -17.1 and -16.18 in the laughter group. More results are presented in Table 2.

Table 2 Comparison of Kyphosis, Forward Head, and Round Shoulder within and between groups

Variable	Group	Pre-test X ± SD	Post-test X ± SD	F	*P*	ES	Main effect of group	
							F	P
Kyphosis (D)	M	48.9 ± 4.8	35.9 ± 3.18	20.6	0.001*	0.91	15.48	<0.001*
	LG	48.4 ± 3.7	42.6 ± 3.79	20.4	0.001*	0.19		
Forward Head (D)	M	45.2 ± 4.8	35.8 ± 2.4	5.05	0.036*	0.90	5.05	0.064
	LG	46.7 ± 1.56	38.02 ± 1.94	10.17	0.001*	0.79		
Round Shoulder (D)	M	55.9 ± 2.6	38.8 ± 1.4	170.7	0.001*	0.89	15.1	0.058
	LG	56.2 ± 2.18	40.02 ± 1.94	130.17	0.001*	0.83		

* Significance at the level of p <0.05. V: volt, D: Degree, X: Mean, SD: Standard deviation, ES: Effect Size, M: Music, LG: laugher.

Comparison of muscle electrical activity within and between groups

The difference in the mean values between the pre-test and post-test in the electrical activities of the measured muscles showed that in the sternocleidomastoid muscle, the music group was -38.27 and the laughter group was 22.63, in the upper trapezius group was -64.09 and the laughter group was -60.17, in the middle trapezius group was 63.9 and the laughter group was 49.3, in the lower trapezius group was 34.05 and the laughter group was 16.18, in the pectoralis major group was 36.24 and the laughter group was 67.53, in the sternum group was -44.34 and the laughter group was -68.4, in the serratus anterior muscle was 34.82 and the laughter group was 27.06, and finally in the latissimus dorsi muscle was 28.28 and the laughter group was

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18.99. Changes in all muscle electrical activity were greater in the music group, with the only exception being the pectoralis major muscle, which showed greater changes in the laughter group. Further results are presented in Table 3.

Table 3 Comparison of muscle electrical activity within and between groups

Variable	Group	Pre-test X ± SD	Post-test X ± SD	F	*P*	ES	Main effect of group	
							F	P
Sternocleidomastoid (V)	M	63.39 ± 30.9	25.12 ± 14.19	26.38	0.001*	0.74	0.49	0.69
	LG	17.76 ± 27.94	40.39 ± 42.56	14.27	0.03*	0.53		
Upper Trapezius (V)	M	120.57 ± 63.47	56.48 ± 36.58	16.79	0.001*	0.72	2.7	0.17
	LG	114.88 ± 57.34	54.71 ± 79.1	34.20	0.02*	0.51		
Middle Trapezius (V)	M	77.25 ± 20.85	141.15 ± 47.34	14.96	0.001*	0.66	7.92	0.06
	LG	79.8 ± 27.44	129.1 ± 28.71	43.36	0.001*	0.35		
Lower Trapezius (V)	M	61.99 ± 26.55	96.04 ± 21.32	71.98	0.001*	0.53	0.42	0.62
	LG	58.21 ± 11.72	74.39 ± 29.51	16.16	0.001*	0.35		
Pectoralis Major (Sternum) (V)	M	27.82 ± 13.65	64.06 ± 35.51	14.9	0.003*	0.66	5.01	0.083
	LG	21.49 ± 11.31	89.02 ± 13.47	40.98	0.001*	0.32		

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Pectoralis Major (Clavicle) (V)	M	93.89 ± 57.43	49.55 ± 29.05	13.9	0.003	0.57	0.13	0.89
	LG	100.24 ± 39.9	31.84 ± 42.39	52.02	0.001*	0.27		
Seratus Anterior (V)	M	66.74 ± 42.03	101.56 ± 61.81	4.10	0.002*	0.58	0.60	0.41
	LG	65.25 ± 26.41	92.31 ± 21.94	14.48	0.001*	0.23		
Lattismus Dorsi (V)	M	62.37 ± 41.61	90.65 ± 37.68	30.69	0.004*	0.55	0.17	0.68
	LG	54.04 ± 11.79	73.03 ± 20.71	15.70	0.001*	0.21		

* Significance at the level of p <0.05. V: volt, D: Degree, X: Mean, SD: Standard deviation, ES: Effect Size, M: Music, LG: laugher.

Disscusion

Corrective exercise programs are generally designed to restore postural alignment, muscle balance, and movement control rather than to address isolated muscular abnormalities. Given that corrective exercise has consistently been shown to improve postural alignment, the present study sought to determine whether supplementing a corrective exercise program with music or laughter therapy would yield distinct postural and neuromuscular (EMG) outcomes.

The results demonstrated significant within-group improvements in thoracic kyphosis, forward head angle, and rounded shoulder angle following both eight-week combined interventions. In the between-group analysis, however, a significant difference emerged only for kyphosis ($P < 0.001$), whereas no significant between-group differences were observed for forward head angle ($P = 0.064$) or rounded shoulder angle ($P = 0.058$). Taken together, these findings suggest that the two combined intervention modalities produced broadly comparable improvements

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across most postural outcomes, with a modality-specific effect observed only for thoracic kyphosis.

Our findings regarding postural correction align with the high-level evidence synthesized in the recent systematic review and meta-analysis, which confirmed that corrective exercises produce robust improvements in forward head angle, rounded shoulder angle, and thoracic hyper-kyphosis (28). These results are further consistent with individual trials by Abdollahzadeh et al. (2019) and Arshadi et al. (2019), which demonstrated the clinical efficacy of targeted corrective protocols in individuals with UCS (2, 4). Although the corrective exercises in the current study were supplemented with music or laughter therapy, the observed postural adaptations were consistent with those of the aforementioned studies. This convergence is likely attributable to the shared primary objective of all corrective programs, namely the restoration of muscular balance. In UCS, the upper trapezius and pectoral muscles become shortened and overactive, whereas the middle and lower trapezius, deep neck flexors, serratus anterior, and latissimus dorsi become elongated and inhibited. Because displaced muscle fibers operate at non-optimal lengths, their contractile capacity is compromised, resulting in functional weakness across both muscle groups (29, 30). Accordingly, the corrective program in the present study addressed these muscles concurrently in terms of both strength and length (18, 31).

Importantly, while the recent meta-analysis highlighted that the available evidence regarding muscle activation and EMG outcomes in UCS remains inconsistent and of moderate-to-low certainty (28), the present study provides empirical data demonstrating consistent neuromuscular adaptations. Specifically, following both eight-week interventions, hyperactive and shortened muscles namely the sternocleidomastoid, upper trapezius, and clavicular head of the pectoralis major exhibited reduced EMG amplitude, whereas inhibited and elongated muscles namely the middle trapezius, lower trapezius, serratus anterior, and latissimus dorsi

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demonstrated increased activity ($P < 0.05$). With respect to the adjunctive modalities, the observed neuromuscular and postural improvements are in line with the broader literature documenting the positive effects of music on human health and motor performance (10, 25, 30), thereby supporting the plausibility of integrating music-based interventions into corrective exercise frameworks.

The observed alterations in surface EMG amplitude reflect profound neuromuscular adaptations following the corrective exercise interventions. In UCS, the disruption of scapular kinematics often driven by malalignment triggers a cascade of compensatory muscle activities (1, 35). Specifically, the imbalance between the upper and lower trapezius, which function as a critical force couple, leads to scapular downward rotation and subsequent involvement of the serratus anterior, which becomes both weak and elongated (1). Our findings demonstrate that the corrective protocols effectively addressed these imbalances: the hyperactive and shortened muscles (SCM, upper trapezius, and clavicular pectoralis major) exhibited significant reductions in EMG amplitude, while the inhibited and elongated muscles (middle and lower trapezius, serratus anterior, latissimus dorsi, and sternal pectoralis major) showed significant increases in electrical activity ($P < 0.05$).

These neuromuscular shifts are consistent with Sherrington's Law of Reciprocal Inhibition, where the reduction in tension of shortened antagonist muscles facilitates the functional recovery of the agonists (1, 18). Furthermore, the reduction in SCM activity is particularly noteworthy. In UCS, forward head posture shifts the head's center of gravity anteriorly, imposing an increased mechanical load on the SCM. This often results in a compensatory overactivity of the SCM to stabilize the cranium, despite its elongated state (1). By restoring postural alignment, our intervention likely mitigated this compensatory demand, thereby normalizing the SCM's electrical activity.

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The efficacy of these neuromuscular adaptations aligns with previous research by Proshottaman et al., who demonstrated that targeted corrective exercises significantly influence muscle electrical activity (34). Additionally, the integration of music/laughter as an adjunct may have facilitated these improvements. For instance, Meklin et al. (2013) noted that music supplementation enhances the effectiveness of exercise programs in elderly populations, improving motor stability (32). While the primary driver of our results was the corrective exercise itself, the positive psychological and sensory impact of the adjunctive modalities may have played a role in enhancing motor engagement.

Despite these insights, several limitations must be acknowledged. First, while the study demonstrated robust neuromuscular adaptations, the specific neurophysiological mechanisms such as changes in motor unit recruitment or firing rates were not directly assessed via high-density EMG or similar advanced modalities (33). Second, the potential contribution of music or laughter to exercise engagement remains speculative, as these psychological variables were not formally measured. Consequently, these factors should be interpreted as potential contributors rather than established causal mechanisms.

It is imperative to distinguish between absolute muscular strength and changes in electrical activity recorded via EMG. The observed increases in EMG amplitude for previously inhibited muscles do not necessarily denote an increase in maximal force production; rather, they likely reflect alterations in motor unit recruitment patterns and firing rates. In the context of the kinetic chain, the dysfunction of scapular stabilizers (e.g., serratus anterior and lower trapezius) forces the upper trapezius and SCM to undergo compensatory hypertrophy of activity to maintain postural stability. Our findings suggest that the corrective interventions facilitated a neuromuscular re-education process (1). By restoring muscular balance and force-couple symmetry, the excessive compensatory load on the SCM and upper trapezius was alleviated, allowing these muscles to return to a normalized electrical state while the primary stabilizers

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regained their functional recruitment capacity. This restoration of synergistic activation patterns is fundamental to stabilizing the scapulothoracic rhythm.

Interestingly, despite the significant within-group improvements, no statistically significant differences were observed between the music and laughter therapy groups ($P > 0.05$). This suggests that both modalities, when integrated into a standardized corrective framework, may operate through shared psychophysiological pathways. In the present study, music was strategically modulated to match the exercise intensity utilizing low-tempo, calming music during the relaxation phase and higher-tempo rhythms during the activation phase. This synchronization likely enhanced movement fluidity and motor engagement. Similarly, the integration of laughter yoga may have mitigated the psychological perception of fatigue and increased exercise tolerance (36).

Both music and laughter appear to act as potent catalysts for neuromuscular efficiency. By potentially lowering the perceived rate of exertion (RPE) and enhancing arousal levels, these adjuncts may have allowed participants to maintain higher-quality movement patterns and more effective motor unit recruitment throughout the eight-week period. Consequently, the lack of a significant between-group difference suggests that while the sensory-emotional drivers (auditory vs. social-emotional) differ, their ultimate impact on the physiological correction of UCS may be comparable in effectiveness.

Limitation

Several limitations should be considered when interpreting the findings. First, the study included only female employees, which limits the generalizability of the findings to male populations and other occupational groups. Second, the absence of a corrective-exercise-only control group prevented determination of the additional effects of music or laughter beyond corrective exercise alone. Third, no follow-up assessment was performed; therefore, the

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durability of the observed postural and EMG changes remains unknown. Finally, motivation, adherence, perceived fatigue, and other psychological responses were not directly measured, limiting the ability to establish these factors as mechanisms underlying the observed effects. In addition, the lack of assessor blinding may have introduced the possibility of measurement bias.

Conclusion

In conclusion, the present study demonstrates that both music-integrated and laughter-based corrective exercise programs induce significant improvements in postural alignment and neuromuscular activation patterns among female employees with UCS. While the comparative analysis revealed no significant differences between the two modalities regarding most EMG variables and postural indices with the notable exception of the kyphosis angle these findings underscore the efficacy of both approaches as viable therapeutic strategies. Although this study did not include a standalone corrective-exercise-only control group, the observed improvements suggest that integrating engaging adjunctive elements such as music and laughter into standard protocols may enhance the therapeutic process, likely through improved patient adherence, psychological well-being, and psychophysiological arousal. These modalities may serve as powerful catalysts for neuromuscular re-education and postural correction. Future research should utilize randomized controlled trials with a control group (corrective exercise alone) to isolate the specific additive effects of these interventions. Moreover, direct investigation into the neurophysiological mechanisms such as the influence of these modalities on motor unit firing rates, psychological motivation, and perceived exertion is warranted to fully elucidate how these creative approaches optimize physical rehabilitation outcomes.

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Statements and Declarations

Not applicable

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