Research Paper

Effect of A Selected Corrective Exercise Program on the Function and Proprioception of the Cervical Area in People With Depression and Upper Crossed Syndrome

Taleb Fadaei Dehcheshmeh[1], Ali Shamsi Majelan[1*], Hassan Daneshmandi[1]

1. Department of Corrective Exercise and Sport Injuries, School of Physical Education and Sport Sciences, University of Guilan, Rasht, Iran.

Use your device to scan and read the article online

Citation Fadaei Dehcheshmeh T, Shamsi Majelan A, Daneshmandi H. Effect of A Selected Corrective Exercise Program on the Function and Proprioception of the Cervical Area in People With Depression and Upper Crossed Syndrome. Iranian Rehabilitation Journal. 2024; 22(1):83-94. http://dx.doi.org/10.32598/irj.22.1.1971.1

http://dx.doi.org/10.32598/irj.22.1.1971.1

CC BY NC

Article info:
Received: 05 Dec 2022
Accepted: 29 May 2023
Available Online: 01 Mar 2024

Keywords:
Corrective exercises, Upper extremity function, Cervical joint position error, Depression, Upper crossed syndrome

ABSTRACT

Objectives: The incidence of the upper cross syndrome is common in people with depressive disorders due to being in constant and repetitive positions. Due to diseases in the upper quadrant of the body in this syndrome, the proper function of sensory receptors in the ligaments is impaired. This study aimed to investigate the effect of a selected corrective exercise program course on the function and proprioception of the cervical area in people with depression and upper crossed syndrome.

Methods: Thirty people with depressive disorder were purposefully selected and divided into two groups: Experimental and control. The Beck depression questionnaire was used to measure depression. The upper extremity functions and joint position error were measured by a Y-balance device and a cervical range of motion device. The experimental group received the selected corrective exercise program.

Results: The selected corrective exercise program had a significant effect on the variables of upper extremity functions and proprioception in the cervical area.

Discussion: The corrective exercises of the present study can be recommended to experts as an effective method or treatment to improve posture, function, and cervical proprioception in people with depression who have the upper crossed syndrome.

*** Corresponding Author:**
Ali Shamsi Majelan, Assistant Professor.
Address: *Department of Corrective Exercise and Sport Injuries, School of Physical Education and Sport Sciences, University of Guilan, Rasht, Iran.*
Tel: *+98 (911) 9312443*
E-mail: *alishamsim@yahoo.com*

Highlights

- Posture and depression affect each other.
- Corrective exercises lead to improved proprioception of the cervical area in depressed people.
- Corrective exercises lead to improved function in depressed people.

Plain Language Summary

One of the most common mental disorders is depression, which is the main reason for visiting the clinic. The corrective exercises are the key step to designing appropriate and effective therapeutic interventions. The exercises can be recommended to experts as an effective way to improve body function, daily activities, and balance in people with depression. In general, these exercises can be recommended to professionals as an effective way to perform daily activities in people with depression.

Introduction

Depression and anxiety are among the most common psychiatric disorders [1]. Depression is one of the four major diseases in the world and the most common cause of disability caused by diseases [1]. About 121 million people in the world struggle with problems related to depression [2]. The prevalence of this disorder has been reported differently in different countries so that in Japan and China, the lowest prevalence of depression (6%) and in Brazil and New Zealand the highest prevalence of depression (20%), have been observed [3]. Based on assumptions, the main mechanisms of major depressive disorder include inflammation, disruption, and lack of coordination in hypothalamus function and neurotrophic elements, including neurotrophic factors derived from the brain [4]. Its specific symptoms include loss of energy and interests, low self-confidence, feelings of sadness and guilt, and changes in appetite and sleep patterns, which are associated with differences and similarities in men, women, children, and the elderly, which ultimately reduce the quality of life and the performance of the individuals [5]. One of the important long-term effects of depression is the body's deviation from its normal state. People suffering from depression are in an isolated state for a long time; thus, their physical condition will be affected [6]. In this regard, people with depressive disorders have increased anterior tilt of the head, hyperkyphosis of the thoracic spine, and a heightened state of scapula abduction [7]. Postural deviations and abnormalities can result from factors, such as prolonged static postures, repetitive movements, muscular weaknesses in deep muscle groups, neuro-muscular control deficiencies, physical inactivity, or the inability of tissues to return to their initial state after activity [8]. One specific deviation affecting the upper quarter of the body is known as upper crossed syndrome [9]. In the upper crossed syndrome, which affects the neck and shoulder girdle, the posterior-superior muscles (levator scapula muscle and the upper part of the trapezius) and anterior chest (pectoralis major and minor), which are among the muscles of the tonic system, become tense. Meanwhile, the parallelogram muscles, which consist of the middle and lower trapezius, serratus anterior, and deep neck flexors, primarily fall under the phasic muscle system and tend to weaken [10]. This syndrome leads to widespread changes, such as head forward, increased cervical lordosis, dorsal kyphosis, rounded shoulders, shoulder abduction and winging, and reduced stability of the glenohumeral joint in the upper quarter of the body [9]. Disorders of the spine and the occurrence of the upper cross syndrome are associated with poor balance and reduced function, and any disorder in the spine affects the proper function of the deep receptors inside the ligaments and disrupts the sense of joint condition [11]. In other words, proprioceptive receptors are located in muscles, joints, and skin. Muscle receptors are thought to be most important in providing proprioceptive information [12]. The concentration of these receptors in the neck area and deep muscles is more than surface muscles. The occurrence of upper crossed syndrome abnormality changes the length of anterior and posterior neck muscles so that most of the superficial muscles are shortened and the deep muscles are lengthened and weakened, and these changes in muscle length and tension damage joint sense in the neck region [12]. Ha and Sung showed that the forward head position increases the absolute error of returning to a neutral position in returning from the full range of forward, backward, and side-to-side head flex-

ion [13]. In the realm of corrective measures, therapeutic exercise or the utilization of corrective movements is a commonly employed approach for rectifying upper crossed syndrome deformities. Consequently, it can effectively enhance the perception of joint conditions in the neck region and improve overall performance. In the field of physical deformity correction, there are innovative methods, including corrective games and postural exercises tailored to specific deformities [14, 15]. Another noteworthy technique for addressing incorrect posture patterns is teaching proper posture and addressing bodily irregularities in daily activities, a method that has gained considerable attention recently [15]. Also, corrective games represent a novel approach to correction, holding significant value at the intersection of rehabilitation and psychological techniques in terms of education and therapeutic training. Corrective games utilize natural means of expression, such as play, to serve as a therapeutic method for individuals dealing with mental health issues, aiding them in managing their emotional pressures. Considering the enjoyment and compatibility of such movement activities with the physical and mental abnormalities of people suffering from depression, these games can increase their enthusiasm and interest in physical activity. They promote the coordinated development of various body organs and parts, establishing an appropriate length-tension relationship with muscles, and ultimately improving joint position sense and function in individuals with depression [16].

To date, there have been no studies investigating the identification and correction of upper limb misalignment, proprioceptive sensation in the neck region, and movement function in individuals with depression who have upper-cross syndrome. Therefore, the current research intended to compare the changes made in proprioceptive sensation in the neck region and upper limb function in patients with depression before and after the implementation of a program of selected corrective exercises. Given the importance of corrective exercises in preventing postural misalignments, improving upper extremity function, and proprioceptive sensation in the neck region for individuals with depression, and the existing research gap in this area, the researcher conducted the current study.

Materials and Methods

Participants

The current quasi-experimental research followed a pre-test and post-test design. Based on the research topic, people suffering from depression with an age range of 18 to 40 years were introduced as the statistical population. Among them, 30 people were selected as the sample based on available sampling. G*Power software, version 3.1.9.4 was used to determine the sample size. Accordingly, 290 people were numbered at first and then, the sample size was estimated by the software. Even numbers were assigned to the experimental group and odd numbers to the control group. Finally, 15 people were considered as the experimental group and 15 people as the control group.

Procedures

Patients with forward head deformity (>46 degrees), kyphosis deformity (>42 degrees), and shoulder forward deformity (>52 degrees) were included in the study [10]. Other inclusion criteria were depression with a score between 19 and 27 [17]. The exclusion criteria were the problems related to articular disc destruction disorders, spinal cord problems, respiratory and cardiovascular problems, and no history of surgery in the upper and lower body. Also, cases, such as severe vision and hearing disorders, neurological diseases, the presence of orthopedic lesions in the upper and lower limbs, and injury in the training period or during sports activities were considered as exclusion criteria [10].

After coordinating with the officials and confirming their readiness, the researcher visited the Mental and Health Center of Hajar Hospital, located in Shahr-e Kord. Following the approval of the subscription by the Ethics Committee of the Sport Sciences Research Institute, the participants were randomly divided into two groups: An experimental group and a control group. This division was done by selecting numbers 1 and 2 from inside sealed envelopes.

To evaluate the level of depression among the participants, Beck's depression inventory (BDI) (1961) was used [17]. The BDI was initially prepared by Aaron T. Beck in the 1960s to measure and evaluate the presence or absence of depression as well as its severity in adolescents and adults. It was revised in 1971 and published in 1978 and comprises 21 questions, each with four response options (0-1-2-3). People marked the option that best expressed their feelings about their mental state during the week by checking the corresponding boxes. Out of these questions, 15 were related to mental and emotional states, while 6 pertained to the subjects' physical states. The total score was calculated by adding together the scores from both the mental and physical sections. This total score could range from 0 to 63. Individuals who scored between 0 and 9 were categorized as not hav-

ing depression. A score falling within the range of 10 to 15 indicated mild depression, while a score between 17 and 29 indicated moderate depression and a score above 30 indicated severe depression [17]. The validity and reliability of this questionnaire have been confirmed in previous studies, such as those conducted by Mark and Mendelson [17] Based on our research objective, people with moderate degrees of depression were included in the study.

Upper extremity function testing

The Y balance device was used to evaluate upper extremity function [18]. Gorman et al. (2012) reported an intra-rater coefficient of correlation (ICC) of 0.80-0.99 and an inter-examiner ICC of 1.00 [18]. This device consists of a fixed plate to which three rods are connected in three directions: internal, lower-external, and upper-external, positioned at angles of 120 degrees to each other. Each rod was marked in centimeters, and there was a moving indicator on each graded rod that the subject's free hand pushed to achieve maximum reach distance. The subject first placed his non-dominant hand on the stationary plate for support and was placed in the Swedish swimming position. Then, he moved his dominant hand for the maximum reaching distance in the internal direction, immediately in the lower-external direction and then in the upper-external direction, and then, he returned to the initial position of the test. The subject tried all three directions three times and their average was calculated. For normalization, data were divided by upper extremity length. For the final score, the sum of the total scores divided by the body was multiplied by three and the obtained number was multiplied by 100 [18].

Cervical JPE testing

To evaluate the range of motion of the cervical region, the study by Lee et al. [19]. was modeled. To perform the assessment, the subject was placed in a sitting position on a chair placed on the floor so that the head was in a neutral position [20]. During the assessment, a mask was used over the subjects' eyes to fix the movement of the head and neck area. The tester firmly placed the instrument on the subject's head using a cloth. The north direction sign of the device was placed on the person's shoulder [21]. Then, the device was calibrated in the same state. The validity and reliability of this device are between 0.62 and 0.91. To evaluate the range of motion, the device was placed on the head and the subject slowly moved his head in the direction of the tested target [21] and held this position for 3 seconds. Then, he/she returned the head to the first position [22]. Again, he moved the head towards the target, and then, the error level in the position of the neck region was evaluated in terms of degrees. The range of the cervical region was measured in flexion, extension, lateral, and medial rotation. Finally, each of the modes was evaluated three times and the average error of neck position sense was recorded. During the test, the patient received no feedback [23]. After the evaluations of variables in the pretest, for eight weeks and three sessions per week, the experimental group performed selected corrective exercises (corrective exercises, postural correction training, and corrective games). During this period, the control group did not experience any training. Finally, after performing the selected corrective exercises, the mentioned variables were measured again in the post-test.

Selected corrective exercises: The functional and corrective exercises in this study were based on the agreement and opinion of the researchers, and their layout and design were based on Saharman's corrective protocol. These exercises are the result of functional exercises, designed games, and exercises related to training how to correct body posture and remove wrong patterns, which were completed in eight weeks and three sessions every week. The exercises started with warming up for 10 minutes. The main exercise lasted 45 minutes and the cooling time at the end of the exercise was 10 minutes. The level of exercises progressed from simple to complex exercises from the beginning to the end of the training sessions. During training, the training load was added gradually based on the pattern of load increase. Also, the principles of individual characteristics were followed (Table 1). The rest period between each set was 45 seconds and the amount of rest between these types of exercises was 90 seconds due to high pressure [24] (Table 1).

Corrective games: In this study, corrective games were designed and used using previous studies [25, 26]. The content of these games was used to reduce and improve the mental and psychological condition of the subjects based on the improvement of spinal postural abnormalities and also because it was more of an entertainment aspect (Table 2).

Exercises to correct body deviations: In this section, because the subjects had postural abnormalities of the upper crossed syndrome, a postural correction program was considered for them in accordance with this type of abnormality. At the beginning of the exercise, they were talked about being in a normal position, and their postural mistakes were corrected, and the subjects were warned to put their posture in the correct position during all daily activities [27] (Table 3).

Table 1. The corrective exercise protocol

Row	The Purpose of the Exercise	How to Do The Exercise	Set and Repeat
1	Increased muscle recruitment and activity of the neck flexor muscles in the prone position	At the same time, by placing the forehead on the ground and turning the head back, performing the cross movement using the theraband	Two sets of 10 (1st and 2nd weeks) Three sets of 10 (3rd and 4th weeks) Three sets of 15 (5th and 6th weeks) Three sets of 20 (7th and 8th weeks)
2	Increased muscle recruitment and activity of the intrinsic muscles of the neck in the quadruped position	The examiner made the curve of the subject's spine parallel to the ground in the quadruped position, and then the subject turned his/her head and neck backward in this position so that he/she felt his/her neck around a bar that passed through the middle of the neck, and turned backward.	Two sets of 10 (1st and 2nd weeks) Three sets of 10 (3rd and 4th weeks) Three sets of 15 (5th and 6th weeks) Three sets of 20 (7th and 8th weeks)
3	Increased muscle recruitment and activity of the intrinsic muscles of the neck in the supine position	The patient was placed in a supine position and his/her knees were bent to 90 degrees. A towel was placed under the patient's head, and in this position, the person turned his/her chin forward and performed the chin-tuck movement. During this exercise, the patient should feel the stretch in the back of the neck. In other words, the recruitment of intrinsic neck muscles increased with this movement.	Two sets of 10 (1st and 2nd weeks) Three sets of 10 (3rd and 4th weeks) Three sets of 15 (5th and 6th weeks) Three sets of 20 (7th and 8th weeks)
4	Carrying out shoulder joint lifting and flexion exercises against the resistance of the band	The patient was placed with his/her back to the wall and in a position where his/her palms were in front of his/her face, performed external rotation and flexion of the shoulder joint to the target angle of 90 degrees, then the shoulder joint flexed against the resistance of the theraband. Meanwhile, the lumbar vertebrae had to be kept in the correct alignment.	Two sets of 10 (1st and 2nd weeks) Three sets of 10 (3rd and 4th weeks) Three sets of 15 (5th and 6th weeks) Three sets of 20 (7th and 8th weeks)
5	While sitting and when the patient's back was against the wall, abduction and external rotation of the shoulder were performed.	The patient placed her/his arms in front of the wall and performed external rotation and abduction of the shoulder joint against the resistance applied from the theraband side, without creating a deviation in the spine.	Two sets of 10 (1st and 2nd weeks) Three sets of 10 (3rd and 4th weeks) Three sets of 15 (5th and 6th weeks) Three sets of 20 (7th and 8th weeks)
6	Exercise sliding forearms up on the wall	The patient faced the wall and placed his/her forearm on the wall, and in this position, focusing on the alignment of the spine and maintaining the correct alignment of the scapula, he/she slid his forearm with the upper side on the wall against the resistance of the theraband. It is important to mention that this action was performed along with the chin-tuck movement.	Two sets of 10 (1st and 2nd weeks) Three sets of 10 (3rd and 4th weeks) Three sets of 15 (5th and 6th weeks) Three sets of 20 (7th and 8th weeks)

Iranian Rehabilitation Journal

Data analysis

To check the normality of the data distribution, the Shapiro-Wilk test was used. The significance level of upper limb function and neck proprioception was 0.05, indicating the normal data distribution. Due to the nature of this study, the analysis of covariance (ANCOVA) was used to examine the intra-group differences of the subjects and also to examine the effect of training on the dependent variable, the paired t-test was used.

Table 2. Corrective game content

Game Name	Content	Exercise Method and Progress
Sliding the snake left and right and landing on the ball	The purpose of the exercise was to increase the flexibility of the back and chest muscles.	Two rounds of play
Carrying a book with the head	The purpose of the exercise was to increase the flexibility of the pectoralis muscles and the internal rotators of the shoulder joint.	Walking on a 12-meter track during the 1st and 2nd weeks. Walking on a path with twists and turns and obstacles 16 meters long during the 3rd and 4th weeks. In the 3rd and 4th weeks, 3 obstacles were installed, and the person had to walk a path of 18 meters through these obstacles. In the last two weeks, he/she had to perform the lunge movement along a 16-meter path.
Passing the ball under the bridge	The purpose of this exercise was to increase the flexibility of the pectoral muscles, the internal rotator muscles of the shoulder joint, and the stretching of the anterior deltoid muscles.	This exercise had to be done in two sets of the game and the length of the track was 12 meters. It was also done during the 1st to 4th weeks. During the last three weeks, the same exercise was done along the 8-meter track.
Carrying a device by an ant	The purpose of this exercise was to increase the recruitment of the deep flexor muscles of the neck area.	In the 1st two weeks, a yellow band was used and walking was performed. In the next two weeks, two obstacles were used to cross. On the other hand, three obstacles were used for the following weeks. The rubber used was yellow. The 7th and 8th weeks were done using red tape and the subject passed three obstacles. The game was played in two rounds.
Catapult-central	The purpose of this exercise was to increase the recruitment of the parallelogram muscles, the middle and lower trapezoid fibers, the shoulder external rotator, and the spine extensors.	The 1th to 4th weeks: Yellow elastic–a ball with the size of 45-elbows in flexion. The 5th to 8th week: Yellow flexible-a bigger ball size-elbows open
Cable car-crossing the river	The purpose of this exercise was to increase the muscle recruitment of the parallelogram muscles, the middle and lower strings of the trapezius.	During the 1st two weeks, the track width was 6 meters, and silver rubber was used. In the 2nd two weeks, the length of the path became 7 meters. In the following weeks, i.e. the 5th and 6th weeks, one meter was added, and in the last two weeks, the path was 8 meters. A silver tape was used.

Iranian Rehabilitation Journal

Table 3. Correction of the posture condition

Row	Exercise Aim	Exercise Method	Set and Repeat
1	Placing the shoulder in the correct position	The person remained standing. At the same time, he/she tried to contract the gluteal muscles and moved the arms outwards and the shoulders back. The action of taking the breath in was done with the external rotation of the shoulders towards the back, and during the exhalation, the person tried to move his/her shoulders down and forward.	6 times a day for 8 weeks
2	Putting the head in the correct position	After straightening the shoulder, the person moved the head back and held this position.	6 times a day for 8 weeks
3	Getting into the correct standing position	This exercise was used to correct bent posture. In the standing position, the shoulders and head went forward so that the center of mass of the body and the center of the heels coincided with each other.	6 times a day for 8 weeks.
4	Getting into the correct sitting position	Keeping the lumbar arch and also rotating the pelvis forward, the person sat on the ischial ridge. In the meantime, he/she moved the chest forward and up. In addition, to reduce and prevent the extension movement of the upper part of the cervical vertebrae, the head and neck area were slightly bent forward.	6 times a day for 8 weeks

Iranian Rehabilitation Journal

Results

Personal characteristics of the subjects of the two experimental and control groups are presented in Table 4. The result of the independent t-test in the pre-test did not show a significant difference, which indicated the homogeneity of the subjects in personal characteristics. The paired t-test results showed that in the experimental group, unlike the control group, there was a significant difference between the pre-test and post-test variables in the performance of the upper extremity and proprioceptive in the neck region (Table 5). The mean pre-test values of the two control and experimental groups were analyzed using an independent t-test, and considering no significant difference in the pre-test, ANCOVA was used to eliminate the minimal effects of the test. In other words, the significant level of upper extremity function and proprioception in the neck region was more significant than 0.05. The equality of variances was checked through Levine's test. The F value obtained for the upper extremity function variable was 4.094 with a P=0.089. On the other hand, for the sense of joint position in flexion, the F=2.969, P=0.101, for extension, the F=2.541,P=0.112 for left rotation, the F=4.740, P=0.079 and finally, for right rotation the obtained F=1.031, P=0.319. Therefore, the hypothesis of homogeneity of variances among the groups was confirmed. The results of ANCOVA to evaluate the effectiveness of the intervention in the performance score of the upper extremity and proprioception of the neck area are presented in Tables 6 and 7. There was a significant difference between the control and intervention groups in both function and proprioceptive of the neck area after the intervention (P≤0.05).

Discussion

The findings of the current research showed that the upper extremity function of studied samples in the intervention group improved after the specified period of time in the pre-test and post-test and this improvement was significant according to the post-test score. No study was found in this field. For this reason, the studies similar to the present study were examined.

Table 4. Demographic information of the research variables

Parameter	Group	Mean±SD	T	P
Age (y)	Control	26.26±3.43	0.438	0.665
	Intervention	25.73±2.23		
Height (m)	Control	174.00±2.13	1.669	0.100
	Intervention	177.93±2.08		
Weight (kg)	Control	74.60±4.45	0.435	0.667
	Intervention	75.33±4.75		

Iranian Rehabilitation Journal

Table 5. Intragroup changes of the research variables in the experimental and control groups before and after the intervention

Variables	Control				Intervention			
	Pre-test	Post-test	T	P	Pre-test	Post-test	T	P
Function	55.26±1.79	55.60±1.91	-0.198	0.895	55.66±2.09	66.13±2.13	21.49	0.000**
JPE in flexion (0)	5.31±1.21	5.33±1.35	-0.910	0.372	5.26±1.68	3.70±1.26	15.473	0.000**
JPE in extension (0)	6.62±0.78	6.67±1.84	-0.664	0.517	6.56±1.71	4.78±1.57	16.541	0.000**
JPE in left rotation (0)	5.62±1.80	5.45±1.95	-0.950	0.358	5.43±1.98	3.12±0.98	16.242	0.000**
JPE in right rotation (0)	5.61±1.80	5.70±1.95	-0.760	0.456	5.59±1.98	4.12±1.98	14.470	0.000**

**Significance at P<0.05.

Iranian Rehabilitation Journal

Table 6. Results of analysis of covariance on the function variables

Source of Changes	SS	DF	MS	F	P	η^2
Test	68.417	1	68.418	39.373	0.000**	0.593
The main effect of groups	773.461	1	773.461	445.117	0.000	0.943
Residual error	46.917	27	1.738			

Iranian Rehabilitation Journal

Abbreviation: η^2: Eta squared; SS: Sum of squares; MS: Mean squares; DF: Degree of freedom.

**Significance at P<0.05.

Özdemir Görgü et al. reported that Schroth's functional exercises are effective in improving spine abnormalities, such as hyperkyphosis. They also affect the quality of life and balance of the elderly [28]. The similarity of the two research on the correction of kyphosis anomaly and its effect on balance can be mentioned. The present research was on depressed people with upper crossed syndrome. Kim et al. investigated the effect of shoulder stability exercises and pectoralis minor muscle stretching on the function and strength of shoulder muscles in healthy young people with rounded shoulder posture and reported a significant improvement in the performance of the subjects [29]. In addition, the present research was in line with the results of the research of Jang et al. (2019) [30]. They examined the effect of stability exercises on balance in older women with kyphosis posture and reported the effectiveness of these exercises. Both studies were similar in terms of placing the deformity kyphosis posture and correcting the deformity [30].

Table 7. Results of analysis of covariance on the cervical area proprioception

Source of Changes		SS	DF	MS	F	P	η^2
Joint position error in flexion (0)	Test	11.782	1	11.782	97.433**	0.000	0.783
	The main effect of groups	24.766	1	24.766	204.797	0.000	0.884
	Residual error	3.265	27	0.121			
Joint position error in extension (0)	Test	11.489	1	11.489	99.454**	0.000	0.786
	The main effect of groups	25.269	1	25.269	218.734	0.000	0.890
	Residual error	3.119	27	0.116			
Joint position error in left rotation (0)	Test	20.947	1	20.947	96.366**	0.000	0.781
	The main effect of groups	9.311	1	9.311	42.838	0.000	0.611
	Residual error	5.869	27	0.217			
JPE in right rotation (0)	Test	10.188	1	10.188	28.954**	0.000	0.517
	The main effect of groups	22.683	1	22.683	64.464	0.000	0.705
	Residual error	9.50	27	0.352			

Iranian Rehabilitation Journal

Abbreviation: η^2: Eta squared; SS: Sum of Squares; MS: Mean squares; DF: Degree of freedom.

**Significance at P<0.05.

Sun et al. also investigated the effect of corrective exercises on posture, balance, and health of older women. The findings of this study showed that a properly designed exercise program could be useful in improving spine posture, balance, and health in older women with kyphosis anomalies [31]. On the other hand, Katzman et al. after implementing a 12-week training program twice a week, reported a 5±3° decrease in the kyphosis angle for women with hyperkyphosis above 50° [25]. There was no significant improvement in the balance and stability of these people. Probably, the reason for the inconsistency between the results of Katzman et al. and our results is the low number of training sessions during the week (two sessions during the week), because at least three training sessions should be done during the week to create the necessary muscle adaptations.

It is concluded that the corrective exercises of the present study, due to strengthening the proprioception of the neck and shoulders, through simultaneous contraction of agonist and antagonist muscles, in addition to the treatment of upper crossed syndrome, might have increased the flexibility of the upper quadrant muscle fibers of the body. This factor can justify the comprehensive corrective exercises used in this research to improve the length-tension relationship in improving performance. From another point of view, in the current corrective exercises, because chin-ups were performed at the same time, and at the same time, scapular retraction exercises were performed with the use of a theraband, this procedure led to an increase in the strengthening and better recall of the small and deep muscles of the neck area and instead of leading to backward movement, they led to backward rotation. This led to the improvement of the length of the lever arm and the strengthening of the intra-articular muscles of the neck, and on the other hand, it led to an increase in the flexibility of the shortened muscles (upper extensors of the neck area). The presence of scapular retraction exercise at the same time as the previous exercise leads to the strengthening of scapular adductor muscles. This causes the mechanical receptors in the cervical and back spine to be stimulated and leads to an improvement in the sense of joint position in the neck area [24]. Also, due to long-term exposure to people with depression, they were advised to have a correct posture during daily activities. Therefore, it is possible that correcting muscle imbalance and reducing the number of upper extremity abnormalities, such as forward head and kyphosis, which are caused by a long posture or repetitive movements on the sagittal (anterior-posterior) surface, improve performance in our subjects [18]. It seems that in addition to corrective exercises, the role of games is also very important in improving performance. According to the researchers of this study, the review and design of each of the games were based on the purpose of the research. For example, in the catapult game, the patient moves his/her shoulders back to catch the ball and must maintain this position, which requires the contraction of the external rotator muscles of the scapula, as well as the lower part of the trapezius muscles and increasing rhomboid muscle recruitment. When these muscles are in a state of contraction, they lead to the improvement of the scapula and increase the stability of the scapula. Another game played in this study was passing under the bridge. In this game, at the same time as playing the bridge, the patient put his/her external rotator muscles and pectoral muscles in a stretched position. On the other hand, one of the prominent features of this game is that while playing it, the shoulder blades are brought together and the vertebrae are stretched and opened. Therefore, performing this exercise puts the alignment of the body in the correct position. All these explanations can be one of the factors to improve one's performance. It seems that this has effectively improved the function of the upper limbs of people suffering from depression.

Other results showed a significant improvement in the range of motion and joint position sense in the neck region due to corrective exercises. The joint position sense in the neck region refers to the interface between the neck and the musculoskeletal system [32]. Afferent information is provided through data from visual, vestibular, and proprioceptive systems. Muscle spindles detect the stretching of agonist muscles and transmit sensory information to the spinal cord through afferent fibers. This data is then relayed to alpha and gamma motor nerves, which, in turn, provide feedback to muscle fibers and muscle spindles, respectively. This process results in muscle contractions that help control excessive postural sway [32]. Clinically, maintaining a stable posture in the body requires coordinated activity and processing of afferent information from all three sensory systems. The cervical spine, in particular, plays a crucial role in proprioception and upper extremity function, with a high density of muscle spindles found in the deeper neck muscles contributing to improved proprioception [33]. A high density of the muscle spindles in the minor deep muscles of the neck plays a crucial role in improving proprioception and upper extremity function (Murphy, 2000). In cases of upper crossed syndrome, functional disorders can arise in the muscle and joint receptors in the neck area, potentially leading to heightened sensitivity of muscle spindles and increased stimulation of gamma motor neurons. This can have a detrimental impact on proprioception and movement control [34]. Although there have been studies in this field, it is worth noting

that their study populations differ from the population of this study. Also, no study was found that specifically focused on the simultaneous impact of corrective exercises, corrective games, and postural correction training on cervical proprioception in individuals suffering from depression. Some studies with certain variables aligned with this research are those by Choi et al. [35], Battal et al. [36], and Lee et al. [37]. Battal et al. reported that upper thoracic region exercises improve cervical proprioception in people with forward head posture. They believed that this was due to an increase in the activity of the Golgi apparatus and muscle spindles [36]. Choi et al. showed that functional exercises as well as the use of kinesio tape improved joint position sense in the neck region in adults with forward head deformity. In their results' justification section, they noted that the improvement in joint position sense in the neck region is linked to reduced pain levels and decreased postural deviations [35]. Also, Kim et al. 2006 investigated the effect of proprioceptive exercises on neck posture reconstruction error in people with chronic neck pain. They reported that proprioceptive training in these people reduces the reconstruction error and the intensity of pain. Regulating the general body posture and movement control depends on a continuous flow of peripheral information, and proprioception is an important part of this information. Proprioception plays a crucial role as it serves as a protective mechanism against movement-related injuries, helps maintain joint stability, and acts as a natural coordinator during physical activities. When proprioception in the joints is compromised, it can disrupt the reflex pathways responsible for stabilizing muscles. This makes the improvement of proprioception particularly significant for individuals with depression. Studies have shown that proprioception is trainable, and rehabilitation programs that emphasize proprioception training have been shown to enhance functional movements [38]. Several studies have emphasized the importance of precise muscle spindle feedback for accurate movements. In individuals with upper crossed syndrome, abnormal stress on the joints can interfere with afferent feedback from muscle spindles and disrupt proprioceptive function [39]. In this context, selected corrective exercises can improve proprioception through several possible mechanisms. These exercises appear to engage the deep flexor muscles of the neck, which are rich in muscle spindles while reducing the activity of superficial flexor neck muscles. The exercises in this study may activate message transmission pathways, increase synaptic connections, and enhance the activity of the Golgi apparatus and the muscle spindles [40].

Conclusion

Eight weeks of the selected corrective program leads to the improvement of upper extremity function and neck proprioception in people suffering from depression with upper crossed syndrome. As a result, the corrective and functional exercises can be used as a comprehensive treatment protocol in improving the disorders related to neck proprioception and increasing upper extremity function in people suffering from depression.

Ethical Considerations

Compliance with ethical guidelines

This research approved by the Ethical Committee of Sport Sciences Research Institute (Code: R1SSRI.REC-2106-1042).

Funding

This article was extracted from the PhD dissertation of Taleb Fadaei Dehcheshmeh, approved by University of Guilan.

Authors' contributions

Conceptualization, investigation, methodology and visualization: Taleb Fadaei Dehcheshmeh; Data curation: Taleb Fadaei Dehcheshmeh and Ali Shamsi Majelan; Writing: Ali Shamsi Majelan and Hassan Daneshmandi; Formal analysis and final approval: All authors.

Conflict of interest

The author declared no conflict of interest.

Acknowledgments

The authors would like to thank the subjects and all the people who somehow contributed to the completion of this study.

References

[1] Brondino N, Rocchetti M, Fusar-Poli L, Codrons E, Correale L, Vandoni M, et al. A systematic review of cognitive effects of exercise in depression. Acta Psychiatrica Scandinavica. 2017; 135(4):285-95. [DOI:10.1111/acps.12690] [PMID]

[2] Heissel A, Zech P, Rapp MA, Schuch FB, Lawrence JB, Kangas M, et al. Effects of exercise on depression and anxiety in persons living with HIV: A meta-analysis. Journal of Psychosomatic Research. 2019; 126:109823. [DOI:10.1016/j.jpsychores.2019.109823] [PMID]

[3] Balchin R, Linde J, Blackhurst D, Rauch HL, Schönbächler G. Sweating away depression? The impact of intensive exercise on depression.Journal of Affective Disorders. 2016; 200:218-21. [DOI:10.1016/j.jad.2016.04.030] [PMID]

[4] Naveen GH, Varambally S, Thirthalli J, Rao M, Christopher R, Gangadhar BN. Serum cortisol and BDNF in patients with major depression-effect of yoga. International Review of Psychiatry. 2016; 28(3):273-8. [DOI:10.1080/09540261.2016.1175419] [PMID]

[5] Salazar G, Marjorie L. Contrast pattern-based classification on sentiment features for detecting people with mental disorders on social media [Master dissertation]. Monterrey: Tecnológico de Monterrey; 2021. [Link]

[6] Kang JH, Park RY, Lee SJ, Kim JY, Yoon SR, Jung KI. The effect of the forward head posture on postural balance in long time computer based worker. Annals of Rehabilitation Medicined. 2012; 36(1):98-104. [DOI:10.5535/arm.2012.36.1.98] [PMID] [PMCID]

[7] Canales JZ, Fiquer JT, Campos RN, Soeiro-de-Souza MG, Moreno RA. Investigation of associations between recurrence of major depressive disorder and spinal posture alignment: A quantitative cross-sectional study. Gait & Posture. 2017; 52:258-64. [DOI:10.1016/j.gaitpost.2016.12.011] [PMID]

[8] Schindel CS, Hommerding PX, Melo DA, Baptista RR, Marostica PJ, Donadio MV. Physical exercise recommendations improve postural changes found in children and adolescents with cystic fibrosis: A randomized controlled trial. The Journal of Pediatrics. 2015; 166(3):710-6. [DOI:10.1016/j.jpeds.2014.12.001] [PMID]

[9] Morris CE, Bonnefin D, Darville C. The torsional upper crossed syndrome: A multi-planar update to Janda's model, with a case series introduction of the mid-pectoral fascial lesion as an associated etiological factor. Journal of Bodywork and Movement Therapies. 2015; 19(4):681-9. [DOI:10.1016/j.jbmt.2015.08.008] [PMID]

[10] Rajalaxmi V, Paul J, Nithya M, Lekha SC, Likitha B. Effectiveness of three dimensional approach of schroth method and yoga on pulmonary function test and posture in upper crossed syndrome with neck pain-A double blinded study. Research Journal of Pharmacy and Technology. 2018; 11(5):1835-9. [DOI:10.5958/0974-360X.2018.00341.4]

[11] Erickson M, Lawrence M, Jansen CWS, Coker D, Amadio P, Cleary C. Hand pain and sensory deficits: Carpal tunnel syndrome. The Journal of Orthopaedic and Sports Physical Therapy. 2019; 49(5):CPG1-85. [DOI:10.2519/jospt.2019.0301] [PMID]

[12] Yong MS, Lee HY, Lee MY. Correlation between head posture and proprioceptive function in the cervical region. Journal of Physical Therapy Science. 2016; 28(3):857-60. [DOI:10.1589/jpts.28.857] [PMID] [PMCID]

[13] Ha SY, Sung YH. A temporary forward head posture decreases function of cervical proprioception. Journal of Exercise Rehabilitation. 2020; 16(2):168-74. [DOI:10.12965/jer.2040106.053] [PMID] [PMCID]

[14] Feng Q, Wang M, Zhang Y, Zhou Y. The effect of a corrective functional exercise program on postural thoracic kyphosis in teenagers: A randomized controlled trial. Clinical Rehabilitation. 2018; 32(1):48-56. [DOI:10.1177/0269215517714591] [PMID]

[15] Miñana-Signes V, Monfort-Pañego M, Rosaleny-Maiques S. Improvement of knowledge and postural habits after an educational intervention program in school students. Journal of Human Sport and Exercise. 2019; 14(1):47–60. [Link]

[16] Arshadi R, Ghasemi GA, Samadi H. Effects of an 8-week selective corrective exercises program on electromyography activity of scapular and neck muscles in persons with upper crossed syndrome: Randomized controlled trial. Physical Therapy in Sport. 2019; 37:113-9. [DOI:10.1016/j.ptsp.2019.03.008] [PMID]

[17] Jackson-Koku G. Beck depression inventory. Occupational Medicine. 2016; 66(2):174-5. [DOI:10.1093/occmed/kqv087] [PMID]

[18] Gorman PP, Butler RJ, Plisky PJ, Kiesel KB. Upper quarter Y balance test: Reliability and performance comparison between genders in active adults. Journal of Strength and Conditioning Research. 2012; 26(11):3043-8. [DOI:10.1519/JSC.0b013e3182472fdb] [PMID]

[19] Lee HY, Wang JD, Yao G, Wang SF. Association between cervicocephalic kinesthetic sensibility and frequency of subclinical neck pain. Manual Therapy. 2008; 13(5):419-25. [DOI:10.1016/j.math.2007.04.001] [PMID]

[20] Capuano-Pucci D, Rheault W, Aukai J, Bracke M, Day R, Pastrick M. Intratester and intertester reliability of the cervical range of motion device. Archives of Physical Medicine and Rehabilitation. 1991; 72(5):338-40. [DOI:10.5555/uri:pii:000399939190254G]

[21] Alahmari K, Reddy RS, Silvian P, Ahmad I, Nagaraj V, Mahtab M. Intra- and inter-rater reliability of neutral head position and target head position tests in patients with and without neck pain. Brazilian Journal of Physical Therapy. 2017; 21(4):259-67. [DOI:10.1016/j.bjpt.2017.05.003] [PMID] [PMCID]

[22] Gong W. Effects of cervical joint manipulation on joint position sense of normal adults. Journal of Physical Therapy Science. 2013; 25(6):721-3. [DOI:10.1589/jpts.25.721] [PMID] [PMCID]

[23] Dover G, Powers ME. Cryotherapy does not impair shoulder joint position sense. Archives of Physical Medicine and Rehabilitation. 2004; 85(8):1241-6. [DOI:10.1016/j.apmr.2003.11.030] [PMID]

[24] Sahrmann SA. Movement system impairment syndromes of the extremities, cervical and thoracic spines. Edinburgh: Elsevier Health Sciences; 2010. [Link]

[25] Katzman WB, Sellmeyer DE, Stewart AL, Wanek L, Hamel KA. Changes in flexed posture, musculoskeletal impairments, and physical performance after group exercise in community-dwelling older women. Archives of Physical Medicine and Rehabilitation. 2007; 88(2):192-9. [DOI:10.1016/j.apmr.2006.10.033] [PMID]

[26] Seidi F, Rajabi R, Ebrahimi I, Alizadeh MH, Minoonejad H. The efficiency of corrective exercise interventions on thoracic hyper-kyphosis angle. Journal of Back and Musculoskeletal Rehabilitation. 2014; 27(1):7-16. [DOI:10.3233/BMR-130411] [PMID]

[27] Dupuis S, Fortin C, Caouette C, Leclair I, Aubin CÉ. Global postural re-education in pediatric idiopathic scoliosis: A biomechanical modeling and analysis of curve reduction during active and assisted self-correction. BMC Musculoskelet Disord. 2018; 19(1):200. [DOI:10.1186/s12891-018-2112-9] [PMID] [PMCID]

[28] Özdemir Görgü S, Algun ZC. A randomized controlled study of the effect of functional exercises on postural kyphosis: Schroth-based three-dimensional exercises versus postural corrective exercises. Disability and Rehabilitation. 2023; 45(12):1992-2002. [DOI:10.1080/09638288.2022.2083244] [PMID]

[29] Kim Y, Lee JM, Wellsandt E, Rosen AB. Comparison of shoulder range of motion, strength, and upper quarter dynamic balance between NCAA division I overhead athletes with and without a history of shoulder injury. Physical Therapy in Sport. 2020; 42:53-60. [DOI:10.1016/j.ptsp.2019.12.007] [PMID]

[30] Jang HJ, Hughes LC, Oh DW, Kim SY. Effects of corrective exercise for thoracic hyperkyphosis on posture, balance, and well-being in older women: A double-blind, group-matched design. Journal of Geriatric Physical Therapy. 2019; 42(3):E17-27. [DOI:10.1519/JPT.0000000000000146] [PMID]

[31] Sun W, Ma X, Wang L, Zhang C, Song Q, Gu H, et al. Effects of Tai Chi chuan and brisk walking exercise on balance ability in elderly women: A randomized controlled trial. Motor Control. 2019; 23(1):100-14. [DOI:10.1123/mc.2017-0055] [PMID]

[32] Ahmadi H, Yalfani A, Gandomi F. [Effect of eight weeks of corrective exercises carried out in water on static and semi dynamic balance on students with upper crossed syndrome) Janda approach (Persian)]. The Scientific Journal of Rehabilitation Medicine. 2020; 9(3):286-96. [DOI:10.22037/jrm.2020.112005.2141]

[33] Blomgren J, Strandell E, Jull G, Vikman I, Röijezon U. Effects of deep cervical flexor training on impaired physiological functions associated with chronic neck pain: A systematic review. BMC Musculoskeletal Disorders. 2018; 19(1):415. [DOI:10.1186/s12891-018-2324-z] [PMID] [PMCID]

[34] Murphy DR. Conservative management of cervical spine syndromes. New York: McGraw-Hill/Appleton & Lange; 2000. [Link]

[35] Choi J. Effect of Kinesiolology taping and posture stabilizing exercise on pain, Craniovertebral angle, proprioception in adults with forward head posture. Journal of International Academy of Physical Therapy Research. 2019; 10(3):1862-7. [DOI:10.20540/JIAPTR.2019.10.3.1862]

[36] Battal G, Ali N, Chamoun R, Hanna-Boutros B. Does the addition of upper thoracic manipulation to proprioceptive training improve cervicocephalic joint position sense and forward head posture in asymptomatic college students? (Korean).Journal of International Academy of Physical Therapy Research. 2021; 12(2):2345-53. [DOI:10.20540/JIAPTR.2021.12.1.2345]

[37] Lee JD, Shin WS. Immediate effects of neuromuscular control exercise on neck pain, range of motion, and proprioception in persons with neck pain. Physical Therapy Rehabilitation Science. 2020; 9(1):1-9. [DOI:10.14474/ptrs.2020.9.1.1]

[38] Kim M, Kang H, Yang H. Effects of cranio-cervical flexion exercise with visual feedback of forward head posture on muscle activity. Journal of The Korean Society of Integrative Medicine. 2020; 8(4):19-27. [DOI:10.15268/ksim.2020.8.4.019]

[39] Bagaianu D, Van Tiggelen D, Duvigneaud N, Stevens V, Schroyen D, Vissenaeken D, et al. Cervical joint position sense in hypobaric conditions: A randomized double-blind controlled trial. Military Medicine. 2017; 182(9):e1969-75. [DOI:10.7205/milmed-d-16-00341] [PMID]

[40] Yoo HJ, Choi JH. Effect of kinesio taping and proprioception training on pain, neck disability, craniovertebral angle, and muscle activity in forward head posture. Journal of International Academy of Physical Therapy Research. 2018; 9(4):1619-25. [DOI:10.20540/JIAPTR.2018.9.4.1619]