



## Original Article

## The Effect of Eight-Week Shoulder Girdle, Pelvic Girdle and Combined Corrective Exercises On Maximal Voluntary Ventilation in Female Students with Upper Crossed Syndrome: A Randomized Clinical Trial

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## ABSTRACT

**Background:** The purpose of this study was to compare the effect of eight-week shoulder girdle, pelvic girdle and combined corrective exercises on maximal voluntary ventilation in female students with upper crossed syndrome.

**Methods:** In this experimental randomized clinical trial, 45 female college students with upper crossed syndrome voluntarily participated and were randomly divided into three equal subgroups including shoulder girdle group, pelvic girdle group and combined group. The three groups performed corrective exercises of eight weeks and three times per week. The maximal voluntary ventilation was assessed before and after intervention.

**Results:** The results showed that the main effect of group was significant ( $P=0.029$ ). The Least Significant Difference (LSD) post-hoc test demonstrated significant differences between combined groups with shoulder girdle group ( $P=0.048$ ) and pelvic girdle group ( $P=0.011$ ), but no significant differences between shoulder and pelvic groups ( $P=0.537$ ). The results showed a greater maximal voluntary ventilation in the combined exercise group than in the other groups. The main effect of time was significant for the three groups ( $P=0.000$ ). There was a significant interaction of groups by time for outcome measurement ( $P=0.000$ ).

**Conclusion:** The results of this study provided preliminary guidance for the use of the comprehensive corrective exercises for simultaneous correction of anomalies.

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## Introduction

Musculoskeletal damages are a major condition among young people. Upper crossed syndrome (UCS) is a model of contrast between weakness and stiffness of the muscles of the cervical and thoracic spines [1]. In UCS, tightness of the upper trapezius and levator scapula on

the dorsal side crosses with the tightness of the pectoralis major and minor muscles. Weakness of the deep cervical flexors crosses ventrally with the weakness of the middle and lower trapezius [2]. UCS is associated with forward head, shoulder posture, and increased thoracic kyphosis, causing destructive changes in the upper quarter of the body and subsequent other parts of body [3]. The status of the upper cross syndrome has developed from active to inactive lifestyle changes. In today's population, upper crossed syndrome is common among all age groups [2]. Students spend many hours a day with a computer,

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watching videos, browsing social media and swiping their lives away on their tablets and smartphones. This posture forces the upper extremity in an awkward position which predisposes a person to upper crossed syndrome abnormalities [2]. The prevalence of UCS in different communities is reported between 20 and 60% [3]. There is an incidence of 11-60% of UCS and 66% for forward head posture among people in the range of 20 to 50 years [4]. According to the data published in Lahore University, the prevalence of this syndrome among students was 37.1%. It seems that the prevalence of the UCS increases with age [5].

It is well established that this pattern of imbalance creates joint dysfunction, particularly at the atlanto-occipital joint, C4-C5 segment, cervicothoracic joint, glenohumeral joint, and T4-T5 segment [5]. This pattern of muscle imbalance is usually seen as a result of maintaining poor posture over long periods of time, as well as frequent overload patterns on the upper limbs [6]. It can also cause compensatory postural abnormalities in the lumbar and pelvic areas, abnormal breathing patterns, lower vital capacity, compromised performance of daily activities, and reduced quality of life [7, 8].

The UCS muscles around the neck, shoulders and chest directly participate in breathing [9]. An imbalance of muscles caused by tension, weakness, or tightness obstructs normal breathing [10]. Hyperkyphosis reduces the amount of space in the chest, mobility of the rib cage, expansion of the lungs, and lung function [11, 12]. Lorbergs et al. reported that individuals with hyperkyphosis have more intense pulmonary impairment [13]. Restrictive ventilatory disorder due to limited thoracic volume can explain the effect of higher kyphosis intensity on lower pulmonary function [12]. Moreover, subjects with kyphosis have less muscle density because excessive kyphosis and muscle weakness may distort thorax mechanics [13]. The forward head and shoulder posture alters the muscle length-tension relationship and the produced force. The change of the force in the respiratory muscles associated with the neck flexors can lead to respiratory dysfunction [13]. Studies reported that intense trunk internal pressure and mitigated expiratory reserve volume can be the result of a forward head posture [14].

*Upper limb function depends* on the core muscles activity [15]. Proper force distribution and optimum force generation occur when the core musculature functions well resulting in minimum compressive, translational, or shearing forces at the joints of upper and lower extremity [16]. Studies reported that core muscles act as a muscular girdle that function as a unit to fix the body and spine, with and without limb movement [17]. Kibler et al. reported that core stability is the capability to control the position and motion of the trunk over the pelvic to allow optimized generation, transfer, and control of force and motion to upper and lower extremity [18]. Correct breathing is vital for the core zone, because the respiratory muscles, especially the diaphragm, is directly active during core exercises [19]. Some recent studies reported an improvement on maximal voluntary ventilation (MVV) by applying core stability exercises and shoulder girdle exercises, separately [10]. The simultaneous correction

of both upper quarter of the body and the central part of the body disorders is more effective than the correct of either part alone. To the best of our knowledge, no study has yet investigated the effect of shoulder girdle, pelvic girdle and combined corrective exercises on MVV in female students with UCS. Therefore, the purpose of the present study is to compare the effect of an eight-week shoulder girdle, pelvic girdle and combined corrective exercises on MVV in female students with UCS.

## Materials and Methods

### Participants

All patients signed an informed written consent before the commencement of the study. Also, ethical approval for this experimental randomized clinical trial was granted by the ethics committee of the University of Isfahan (IR.UI.REC.1399.005) and this study has been registered at the Iranian Registry of Clinical Trials (IRCT20200406046971N1). The sample size was calculated based on a pilot study using the following formula  $(n = \frac{Z_1 \alpha/2 + Z_1 \beta}{2(S_1^2 + S_2^2)} \div (M_1 - M_2))^2$  with an alpha level of 0.05, and power (1-b) of 0.80 [1].

The inclusion criteria included having UCS (forward head posture  $\geq 46^\circ$ , forward shoulder posture  $\geq 52^\circ$  and hyper-kyphosis  $\geq 42^\circ$ ); these abnormalities were recognized in an initial postural screening and after being measured by photogrammetry and flexicurve, respectively. The exclusion criteria were having the presence of neurological disease, scoliosis, failing to attend pre- and post-test, and irregular attendance (up to 3 time absence) in training sessions [1-3].

The method of randomization was a balanced randomization process in which the patients were matched based on age and randomly assigned to three subgroups in equal sample proportions using a table of random numbers. The groups consisted of the shoulder girdle exercises (group 1), pelvic girdle exercises (group 2), comprehensive shoulder and pelvic girdle exercises (group 3).

### Procedures

Forward head and shoulder angles were evaluated using lateral photographic technique. Three anatomical landmarks of measurement were used including right tragus, acromion process of scapula, and spinous process of C-7 [1, 20]. Each subject stood in front of the camera and the right side was photographed. Adobe AutoCAD 2010 was used for measuring the angle among the line connecting C-7 to tragus and the vertical line (forward head angle (ICC=0.92)) and the angle among the line connecting the acromion to C7 and the vertical line (forward shoulder angle (ICC=0.92)) [3, 21].

A flexicurve ruler (60 cm length and 2 cm wide) was used for the measurement of thoracic kyphosis angle ( $r=0.95$ ). Initially, spinous processes of T2 and T12 were recognized and marked [1, 3]. Each subject stood erect with the body weight equally distributed between both feet, and fixed eyes on the opposite wall [22]. The examiner fixed the flexicurve ruler to the thoracic spine. Then, the ruler was removed and the internal edge

curve was drawn onto the graph paper, and the points representing T2 and T12 were joined using a ruled line (thoracic length). The widest point and thoracic length were joined using a ruled line (thoracic height). Then, kyphosis angle ( $^{\circ}$ ) was calculated for each participant using mathematical formula  $\theta = 4 \text{Arctg} (2H/L)$  [21].

In this study, MVV was assessed by a spirometer (Quark-Pulmonary, made in Italia) [23]. Each respiratory maneuver was demonstrated to the subject prior to the test [24]. All subjects performed spirometry to measure the forced expiratory volume within 12-15 seconds. Forced expiratory maneuvers were performed three times with at least a 1-min distance between each test [23, 24].

Corrective exercise programs included local and comprehensive exercises. Also, the local corrective exercises programs were divided into two groups: shoulder girdle [25-27] and pelvic girdle [28-30] exercises. The shoulder girdle corrective exercises were performed based on the guidelines provided in the studies of Roshani et al. [25], Karimian et al. [26] and Abdolazadeh et al. [27]. In the shoulder girdle exercises, lengthening, activation and integration techniques were employed. For the purpose of this study, the shoulder girdle corrective exercises included levator scapulae, trapezius, sternocleidomastoid, pectorals, latissimus dorsi, cervical and scapular muscles [25-27] (Table 1). The pelvic girdle corrective exercises were performed base on the guidelines provided in the studies of Amiri et al. [28], El-Nashar et al. [29], and Marshall et al. [30]. The pelvic girdle corrective exercises were focused on trunk or more specifically the lumbopelvic region of the body. For the purpose of this study, the

pelvic girdle corrective exercises were performed on the Swiss ball or without the Swiss ball to activate the deep abdominal, transverse abdominal, multifidus and internal oblique muscles [28-30] (Table 2).

To determine whether the effects of independent shoulder girdle corrective exercises and pelvic girdle corrective exercises were different from those of combined corrective exercises, another group was added to the design of this study. The comprehensive group was given a combined set of shoulder girdle and pelvic girdle corrective exercises that considered entire vertebral column. The prescribed adjustment plan was designed for 8 weeks, three sessions per week, and each session lasting from 30 to 70 min. The exercises in the initial sessions had lower intensity, repetition, and duration. In later sessions, the exercises will grow more intense based on the capabilities of the participants with exercises becoming harder to follow the workout principles. The intensity of the exercises for stretching exercises was up to the pain threshold and for strength training, the exercises continued to exhaustion. All the exercises were performed based on exercise principles, their intensity and its gradual addition, duration, cumulative load increase, and the movement pattern of engaging in exercises [1, 2, 31]. The cumulative increase in intensity was observed all through from beginner exercises to advanced level exercises under direct supervision.

Data were analyzed using SPSS software version 21 and the level of statistical significance was set at  $P \leq 0.05$ . To ascertain normality of data, values of outcome measurement were subjected to the Kolmogorov-Smirnov (K-S) test.

**Table 1:** Shoulder girdle exercise protocol.

Exercises	Sets	Duration	Repetitions	Tempo	Rest
Levator Scapulae and Trapezius Stretch	1-3	1-4	30 sec	-	
Sternocleidomastoid Stretch	1-3	1-4	30 sec	-	-
Pectoral Stretch	1-3	1-4	30 sec	-	-
Latissimus Dorsi Stretch	1-3	1-4	30 sec	-	-
Chin tuck	1-2	10-15	-	4/2/2	-
Scapular retraction	1-2	10-15	-	4/2/2	-
Resisted Cervical	1-2	10-15	-	4/2/2	-
Combo	1-2	10-15	-	4/2/2	-
Scaption	1-2	10-15	-	4/2/2	-
Chest press	1-2	10-15	-	Slow	30 sec
Squat	1-2	10-15	-	Slow	30 sec
Replacing the sword	1-2	10-15	-	Slow	30 sec

**Table 2:** Pelvic girdle exercise protocol

Exercises	Repeated							
	1	2	3	4	5	6	7	8
Plank	12	16	20	24	28	32	36	45
Push-up	10	12	14	16	18	20	22	24
Brid dog	22	25	28	31	34	38	41	45
Pelvic tilt	14	18	22	26	30	34	38	45
Boat	20	24	28	32	36	40	44	50
Rev-crunch	12	16	20	24	28	32	36	45
Lunge	12	16	20	24	28	32	36	45
Roll	10	12	14	16	18	20	22	24
Y-raise	10	12	14	16	18	20	22	24
T-raise	10	12	14	16	18	20	22	24
Knee tuck	10	12	14	16	18	20	22	24
Curl	10	12	14	16	18	20	22	24

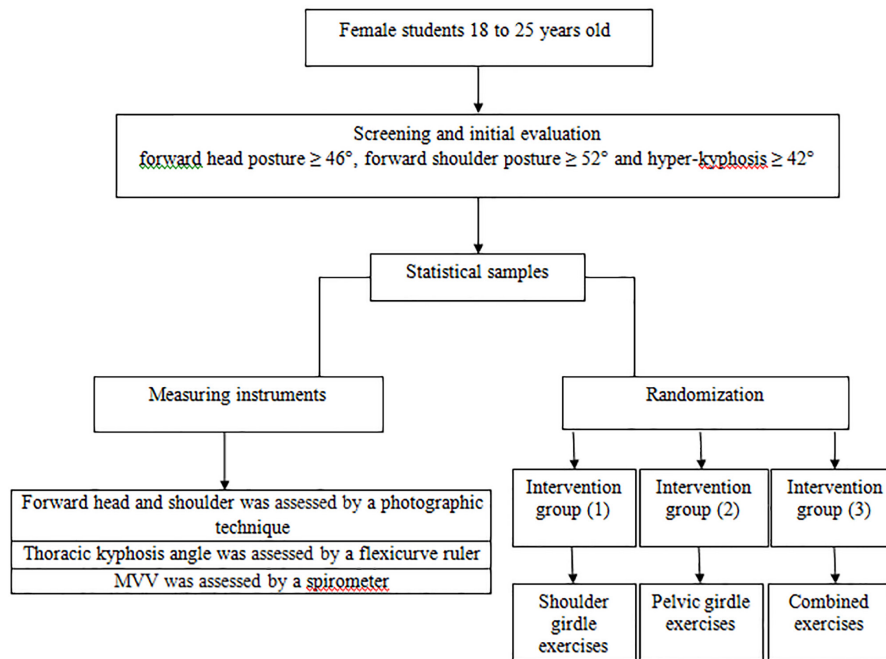


Figure 1: Study flowchart.

Based on the within-subject factor of time (i.e., pre–post test) and the between-subject factor of group (i.e., three study groups), the researchers conducted a  $3 \times 2$  (3 groups by 2 pre–post times) mixed model of the analysis of variance (ANOVA) to determine the main effects and interactions of group and time factors for each outcome measurements [31]. The study flow diagram is shown in Figure 1.

## Results

The demographic characteristics of this study samples are presented in Table 3. Kolmogorov–Smirnov (K-S) test was performed to verify normal distribution of data. The results showed that the three groups of this study did not differ in terms of demographics data related to age, height, weight and BMI ( $P > 0.05$ ).

The Levin's variance used to analyze homogeneity

of variance in the three groups was not statistically significant. The results of the repeated measures ANOVA are presented in Table 4. The results showed that the main effect of group was significant ( $P = 0.029$ ). The LSD post-hoc test demonstrated significant differences between combined groups with shoulder girdle group ( $P = 0.048$ ) and pelvic girdle group ( $P = 0.011$ ), with no significant differences between shoulder and pelvic groups ( $P = 0.537$ ). The results showed a greater improvement MVV in the combined exercise group than in the other groups. The main effect of time was significant for three groups ( $P = 0.000$ ). There was a significant interaction of groups by time for outcome measurements ( $P = 0.000$ ). The simple main effects of time within each experimental group were analyzed (Table 5). The changes of maximum voluntary ventilation in the pre-test and post-test are presented in Figure 2.

Table 3: General characteristics of subjects

Variable	Shoulder girdle group	Pelvic girdle group	Combined group	P value
Age (years)	19.53±1.12	19.00±0.84	20.07±1.71	0.95
Height (cm)	167.07±5.88	161.53±5.95	162.40±4.86	0.58
Weight (kg)	60.53±7.59	54.33±5.31	57.20±4.63	0.49

Data are presented as mean±SD

Table 4: Summary of the analysis of variance for outcome measurement: F-ratios and P values by variable

	Main effects				Interaction	
	Group		Time		Group×Time	
	F-ratio	P value	F-ratio	P value	F-ratio	P value
MVV	3.86	0.03	246.86	0.000	18.67	0.000

P value significant difference level determined by the repeated measures ANOVA ( $P < 0.05$ ; 95%). Maximal voluntary ventilation (MVV)

Table 5: Outcome measurements for the pre–post exercises in the three groups

Group	Pre Mean (SD)	Post Mean (SD)	Difference Mean (SD)	P value
Shoulder girdle group	91.07±8.70	106.33±13.07	–15.27±7.72.	0.000
Pelvic girdle group	90.00±13.30	102.27±10.50	–12.27±7.37	0.000
Combined group	92.53±14.01	121.67±11.58	–29.13±9.00	0.000

P value significant difference level determined by the repeated measures ANOVA ( $P < 0.05$ ; 95%)



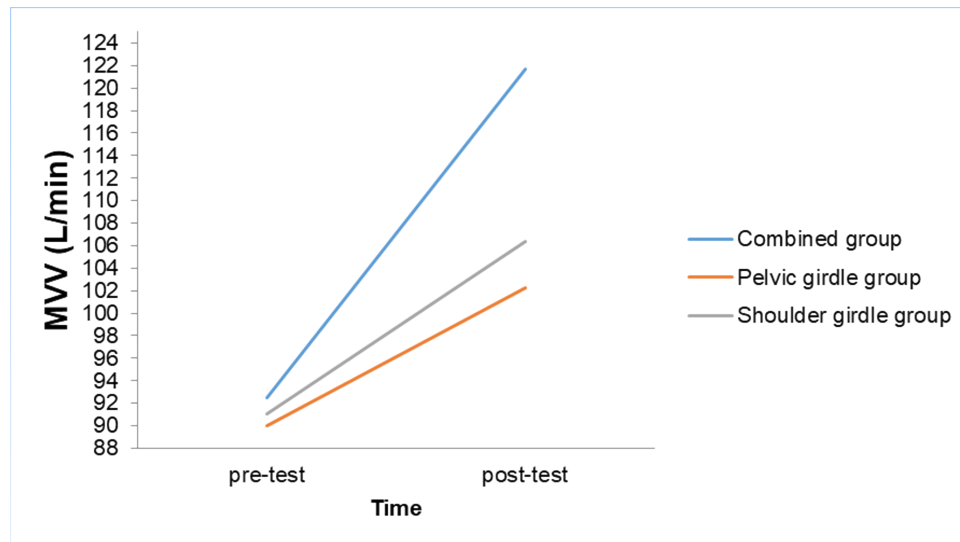


Figure 2: Changes of maximum voluntary ventilation in the pre-test and post-test.

## Discussion

The purpose of this study was to investigate the effects of shoulder girdle, pelvic girdle and combined corrective exercises on MVV subject with UCS. The results indicated that combined corrective exercises resulted in greater improvement in MVV than the shoulder and pelvic girdle exercises. Obtained results showed improvements of MVV in three corrective exercises groups.

The results of this randomized controlled study showed that eight weeks of combined corrective exercise leads to the improvement of MVV in subjects with UCS. The obtained results showed that combined corrective exercises were more efficient than local exercises in improvement of respiratory function. The findings of this research are consistent with previous studies by Szczygieł et al., Kazemi et al. and Cavaggioni et al. [10, 11, 19]. Kazemi et al. reported that vertical excursion and lateral expansion of the rib wall seems to be reduced and is associated with an increasing kyphosis angle. Additionally, compression of the rib cage decreases the curvature of the diaphragm and impairs its movements [11]. Changing of muscle tension in neck and chest can cause changes in posture that lowers the quality of breathing [13]. Breathing depth is reduced by the dynamics of changes in muscular strength and imbalances in the upper limb [12]. Similarly, Diab et al. reported that the changes in neck posture generated concurrent changes throughout the spine [32]. It was revealed in this study that neck corrective exercises can improve deformations throughout the spine and enhance breathing, consequently. Chest flexion or back spinal column changes along the neck spinal column can cause pressure on internal organs and respiratory system, which can be corrected via shoulder girdle corrective exercises. Deep muscles control the depth of breathing [33]. Reduced deep muscle activity leads to shallow breathing [19]. The core corrective exercises applied mainly activated transverse abdominal, multifidus and internal oblique muscles [10]. Pelvic girdle exercises improve muscular chain stretching and respiratory functioning [19].

The results of our study are consistent with the findings obtained by Kirthika et al., Kim and Lee, and Lee et al. [14, 34, 35]. Kim and Lee reported that increasing vital capacity is related to deep abdominal muscle strengthening exercises [34]. Lee et al. showed that trunk muscle training can correct postural deformity by an increase in the amplitude of the rib cage, hence improving the breathing pattern [35]. Combination exercises are clearly used in the rehabilitation and sporting sections, and as a result, rectify proper functioning of the area in question. Because the areas of the spinal column are interconnected through the vertebral system, changes in one area may affect others through a chain reaction [1]. Postural control and breathing are mechanically and neuromuscularly interdependent [17]. Both systems of spinal stability and respiration engage the same muscles and strengthening these muscles enhances posture and respiration [11, 13].

The current study is not without limitations. The first is the small sample size within each experimental group. The second is the lack of a long-term follow-up assessment that limited generalization of the results. Future studies should recruit a larger sample size and include long-term follow-ups to examine potential long-term benefits of corrective exercises.

## Conclusion

Finally, it seems that improvement of MVV can be applied as a corrective method for subjects with UCS. Evidence from the short-term follow-up assessment obtained in this randomized controlled pilot study indicates that shoulder girdle and pelvic girdle corrective exercises had similar effects on MVV in subjects with UCS. Moreover, the comprehensive corrective exercises more effective than local corrective exercises.

**Conflict of Interests:** None declared.

## References

1. Roshani S, Yousefi M, Sokhtezari Z, Khalil Khodaparast M. The effect of a corrective exercise program on upper crossed syndrome

- in a blind person. *J Rehabil Sci.* 2019; 6(3): 148-52.
2. 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). *J Rehab Med.* 2020; 9(3): 286-296.
  3. 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. *Phys Ther Sport.* 2019; 37: 113-9.
  4. Almasoodi MC, Mahdavejad R, Ghasmi G. The effect of 8 weeks national academy of sports medicine exercises training on posture, shoulder pain, and functional disability in male with upper cross syndrome. *J Educ Psychol.* 2021; 58(2): 6741-52.
  5. Sohrobi S, Rahimi M, Babaei-Mobarakeh M, Piri H. The effect of eight weeks of iyengar yoga with an emphasis on spine and shoulder exercises on the upper cross syndrome in middle-aged women. *J Mod Rehabil.* 2020; 14(3): 159-68.
  6. Jiang F, Luo R, Tang J, Ye Y, Zhao YL. Therapeutic observation of manipulation plus exercise therapy in treating upper crossed syndrome postures of primary school students. *J Acupunct Tuina Sci.* 2020; 18(3): 231-7.
  7. Mattox TF, Lucente V, McIntyre P, Miklos JR, Tomezsko J. Abnormal spinal curvature and its relationship to pelvic organ prolapse. *Am J Obstet Gynecol.* 2000; 183(6): 1381-4.
  8. Hasler C, Brunner R, Grundshtein A, Ovardia D. Spine deformities in patients with cerebral palsy; the role of the pelvis. *J Child 's Orthop.* 2020; 14(1): 9-16.
  9. Danazumi MS. Misconceptions about the management of low back pain: a brief note for physiotherapists. *Middle East J Rehab Health Stud.* 2020; 7(2): 1-5.
  10. Szczygieł E, Blaut J, Zielonka-Pycka K, Tomaszewski K, Golec J, Czechowska D et al. The impact of deep muscle training on the quality of posture and breathing. *J Mot Behav.* 2018; 50(2): 219-27.
  11. Kazemi K, Rahmani N, Rahimi F, Ravanbakhsh M. To investigate the association between spinal column deformity and breathing function: a systematic review. *J Bodyw Mov Ther.* 2020; 24(3): 172-180.
  12. Jagger F, Tsirikos AI, Blacklock S, Urquhart DS. Adaptation to reduced lung function in children and young people with spinal deformity. *J Clin Orthop Trauma.* 2020; 11(2): 191-5.
  13. Lorbergs AL, O'Connor GT, Zhou Y, Travison TG, Kiel DP, Cupples LA et al. EJ Severity of kyphosis and decline in lung function: the framingham study. *J Gerontol A Biol Sci Med Sci.* 2017; 72(5): 689-94.
  14. Kirthika SV, Sudhakar S, Padmanabhan K, Ramanathan K. Impact of upper crossed syndrome on pulmonary function among the recreational male players: a preliminary report. *Saudi J. Sports Med.* 2018; 18(2): 71-74.
  15. Tarnanen SP, Siekkinen KM, Häkkinen AH, Mälkiä EA, Kautiainen HJ, Ylinen JJ. Core muscle activation during dynamic upper limb exercises in women. *J Strength Cond Res.* 2012; 26(12): 3217-24.
  16. Neufeld EV, Dolezal BA, Speier W, Cooper CB. Effect of altering breathing frequency on maximum voluntary ventilation in healthy adults. *BMC Pulm Med.* 2018; 18(1): 1-7.
  17. Zafar H, Albarrati A, Alghadir AH, Iqbal ZA. Effect of different head-neck postures on the respiratory function in healthy males. *Biomed Res Int.* 2018; (5):1-4.
  18. Kibler WB, Press J, Sciascia A. The role of core stability in athletic function. *Sports Med.* 2006; 36(3): 189-98.
  19. Cavaggioni L, Ongaro L, Zannin E, Iaia FM, Alberti G. Effects of different core exercises on respiratory parameters and abdominal strength. *J Phys Ther Sci.* 2015; 27(10): 3249-53.
  20. Silva AG, Punt TD, Johnson MI. Reliability and validity of head posture assessment by observation and a four-category scale. *Man Ther.* 2010; 15(5): 490-95.
  21. Vaughn DW, Brown EW. The influence of an in-home based therapeutic exercise program thoracic kyphosis angles. *J Back Musculoskelet Rehabil.* 2007; 20(4): 155-165.
  22. Seidi F, Rajabi R, Ebrahimi I, Alizadeh MH, Minoonejad H. The efficiency of corrective exercise interventions on thoracic hyperkyphosis angle. *J Back Musculoskelet Rehabil.* 2014; 27(1): 7-16.
  23. Razi SS, Petersen WG, Yaktus M, Riggs MW. Correlation of spirometric values with the measured maximal voluntary ventilation (mvv). *Chest.* 2003; 124(4): 122S.
  24. Villamor GA, Andras LM, Redding G, Chan P, Yang J, Skaggs DL. A comparison of maximal voluntary ventilation and forced vital capacity in adolescent idiopathic scoliosis patients. *Spine Deform.* 2019; 7(5): 729-33.
  25. Roshani S, Mahdavejad R, Ghanizadehesar N. The effect of a nasm-based training protocol on upper cross syndrome in paraplegia spinalcord injury patients. *J Ilam Uni Med Sci.* 2018; 25(6): 73-85.
  26. Karimian R, Rahnama N, Ghasemi G, Lenjannejadian S. photogrammetric analysis of upper cross syndrome among teachers and the effects of national academy of sports medicine exercises with ergonomic intervention on the syndrome. *J Res Health Sci.* 2019; 19(3): 1-6.
  27. Abdolhazad M, Daneshmandi H. The effect of an 8-week nasm corrective exercise program on upper crossed syndrome. *J Sport Biomech.* 2019; 5(3): 156-67.
  28. Amiri B, Sahebozamani M, Sedighi B. The effects of 10-week core stability training on balance in women with multiple sclerosis according to expanded disability status scale: a single-blinded randomized controlled trial. *Eur J Phys Rehabil Med.* 2019; 55(2): 199-208.
  29. El-Nashar H, ElWishy A, Helmy H, El-Rwainy R. Do core stability exercises improve upper limb function in chronic stroke patients?. *Egypt J Neurol Psychiatr Neurosurg.* 2019; 55(7): 1-9.
  30. Marshall PW, Murphy BA. Core stability exercises on and off a Swiss ball. *Arch Phys Med Rehab.* 2005; 86(2): 242-49.
  31. Negahban H, Rezaie S, Goharpey S. massage therapy and exercise therapy in patients with multiple sclerosis: a randomized controlled pilot study. *Clin Rehabil.* 2013; 27(12): 1126-36.
  32. Diab AA. The role of forward head correction in management of adolescent idiopathic scoliotic patients: a randomized controlled trial. *Clin Rehabil.* 2012; 26(12): 1123-34.
  33. Mohan V, Paungmali A, Silitertpisan P, Henry LJ, Omar FA, Azhar FZ. The effect of core stability training with ball and balloon exercise on respiratory variables in chronic non-specific low back pain: an experimental study. *J Bodyw Mov Ther.* 2020; 24(4): 196-202.
  34. Kim E, Lee H. The effects of deep abdominal muscle strengthening exercises on respiratory function and lumbar stability. *J Phys Ther Sci.* 2013; 25(6): 663-5.
  35. Lee SH, Lee SG, Choi BR. Effect of trunk stabilization exercises on trunk muscle activation using different respiratory conditions. *J Phys Ther Sci.* 2018; 30(4): 567-9.