

# 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

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## ABSTRACT

**Background:** Upper crossed syndrome (UCS) points to a special malalignment in the upper quarter of the body, including forward head, forward shoulder, and hyper kyphosis posture. We proposed performing an Effect of 8 weeks National Academy of Sports Medicine (NASM) Exercises training on posture, shoulder pain, and functional disability in males with UCS among employees of the Sport and Youth Administration of Karbala province, Iraq.

**Methods:** We involved 30 male volunteers in this pretest-posttest study design. The evaluation of the Forward head (FH), forward shoulder (FSH), thoracic kyphosis (TK), shoulder pain (SHP), and functional disability (FD) were done each participant in random order before and after eight weeks. They were divided into two equal groups of traditional and NASM exercises. Protocols (three times a week, for eight weeks) were performed. So, to compare the mean between pre and posttest data in both groups, independent samples t-test was used. The significance level was established at  $P < 0.05$ .

**Results:** According to the findings independent samples t-test, the forward head angle ( $t = -4.053$ ,  $p = 0.000$ ), forward shoulder angle ( $t = -5.067$ ,  $p = 0.000$ ) and hyperkyphosis angle ( $t = 5.187$ ,  $p = 0.000$ ), shoulder pain ( $t = -3.807$ ,  $p = 0.001$ ), and functional disability ( $t = -3.969$ ,  $p = 0.001$ ) outcomes are presented significant difference after 8 weeks of NASM with traditional exercises.

**Conclusion:** Using the NASM exercises can lead to a reduction in the UCS among employees of the Sport and Youth Administration of Karbala province, Iraq was significantly more than traditional exercises.

**Keywords:** Upper crossed syndrome (UCS), NASM exercises, shoulder pain, functional disability

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## INTRODUCTION

A static and dynamic normal postural pattern in all daily living activities should be maintained to prevent postural misalignments (1). Nevertheless, the sedentary lifestyle and the constant use of electronic and automated devices with a sitting and standing posture in the age of the Internet lead to poor posture of people from different walks of life, especially administrative employees (1–3). Since the posture expresses the mechanical impact of the balance and coordination of the neuromusculoskeletal system and the sense of movement (4), any misalignment can increase neurological or musculoskeletal disorders and may damage the pulmonary function and the quality of life (2,3,5).

Moreover, because of the neck, shoulder, and upper back pain, many individuals will be needed to see a medical practitioner or healthcare provider at least once in their lifetime(6,7) that is responsible for notable expenses, such as healthcare costs, inability insurance, and work absenteeism(8).

Besides the foreseeable influences of UCS have on the health service, shoulder pathology can be very disabling for the sufferer. The socioeconomic consequences are also asserted as the majority of subjects afflicted by shoulder pain are middle-aged in this group, resulting in lost working hours. Some preliminary research confirmed that these pains might be associated with malalignments (9).

Upper cross syndrome (UCS) that was described as a muscular imbalance pattern by Vladimir Janda MD (1923–2002)(10) caused by the specific patterns of altered muscle activity and movement patterns via some postural malalignment (11,12). In this postural appearance, there is an anterior protrusion of the head with increasing in the lordotic curve of the cervical vertebrae (1) and FHP that can provoke many

dysfunctions within the upper body such as headaches, the cervical spine early degeneration, and degeneration of the cervical spine(11,13). There is an incidence of 11–60% of UCS in range societies and ages(14) and 66% for forward head posture among people in 20 to 50yrs (15). Besides, UCS can cause a thoracic hyperkyphotic, anterior tilt, and scapula downward rotation with an inclining tendency and internal rotation of the shoulder (13) that alter the biomechanical alignment of the glenohumeral joint (GHJ), decrease the GHJ stability, and reform in the scapular position(11,12). Indeed, Janda defined that to introduce the effect of forward head posture(FHP) on the muscles (3). This pattern may break the respiratory function and quality of life(16). Moreover, major deviations from optimal alignment can be aesthetically bothersome for people, impact their structural and functional efficiency of muscles, and influence them to be neurological or musculoskeletal dysfunctions (17).

These patterns are prevalent in people who sit and stand a lot or exhibit pattern overload from repeated movement and sustain alignment (11,18). Caneiro et al. reported a relationship between sitting alignment and activity of cervicothoracic muscle (19) and recognized cervical erector spine overactivity in slump sitting. Nevertheless, the correction of postural deviation has been a recommended approach in treating people with dysfunctions of the cervical spine (20). Moreover, the main roles of the sitting (21,22) and standing posture (23,24) were studied as potential risk factors for neck pain (NP). As for the sitting posture, two studies found a correlation between head alignment about the thoracic spine (cervicothoracic angle) (21,22).

The altered movement pattern of the scapula in people with UCS may have altered the electromyography of the neck, shoulder and scapula muscles including upper trapezius(UT), pectoralis muscles(PM) and levator

scapula(LS) over-activity, while serratus anterior(SA), deep neck flexors(DNF) and middle and lower trapezius(MT & LT) under-activity(25). Reducing SA, DNF, MT, and LT activity will be offset by the over activity of the UT that will be accompanied by a reduction in static and dynamic scapular control (26). This increase in the UT activity increases the anterior tilt of the scapula and elevates it, leading to a reduction in glenohumeral joint stability, subacromial space, and various musculoskeletal symptoms in head, neck, and shoulder, which increases the probability of overuse injury and pain of shoulder and neck (25–29). Some studies reported that people with more severe postural malalignment might experience more severe and more frequent pain (15).

Various appropriate exercise interventions have been suggested to correct musculoskeletal malalignments, and reduce pain, mainly through structural and functional approaches. Based on the traditional structural approach, all postural deviations such as UCS due to biomechanics and are assumed to lead to alterations in local muscles' length and strength (18). This approach may be regarded for stretching and strengthening short and weakened muscles in the correction phase, respectively, and locally, while refusing other relevant misalignments (18). Ironically, given this method's popularity, few studies have been carried out on this approach (30). Moreover, some review researches have investigated these exercises' influence to correct postural deviations (16,31). In contrast, based on the functional (neurological) approach to musculoskeletal disorders, generating, regulating, and controlling movement are occur by the cooperation of the central and peripheral nervous systems (10,32). Although muscles can dominate a particular plane of motion, the central nervous system optimizes the determination of muscle synergies and the role of muscles in motor function, not just the assortment of separate muscles (33–35). In comparison, based on the functional (neurological) approach to musculoskeletal disorders, generating and controlling movement are occur by the cooperation of the central and peripheral nervous systems (10,32,36). Besides, malalignments are caused by length and strength muscles and more prominent alterations in neuromuscular factors, such as muscle recruitments (13,37). This altered motor recruitment will change the muscle balance, movement patterns, and the motor program (38). Furthermore, Hodges *et al.* indicated that motor control interventions need to match any person's posture, muscle activity, and movement pattern (39). Nevertheless, this approach has not been inquired in utility for preventing and treating musculoskeletal malalignments.

Consequently, for evaluating UCS, the alignment and the side effects of thoracic hyperkyphosis and forward head angles are usually assessed.

In this way, just one of the affected regions, include the head, shoulders, or spine, independently has been assessed by numerous researchers and therapists. Moreover, it reported a degree of postural deviation despite other related malalignments, muscle activation patterns, and associated movement patterns, such as scapulohumeral rhythm or neck flexion (40–42).

Besides, without considering the neuromuscular factors and relevant movement patterns, most protocols have locally been designed and implemented based on short muscle stretching and weak muscle strengthening exercises (40,43). To the best of our knowledge, few investigations recognizing and improving UCS have

regarding the alignment of the three segments, and their side effects such as chronic function limiting or painful conditions, disability, and pain in evaluation and correction processes.

#### Study objectives

Evaluating the effectiveness of eight weeks of a National Academy of Sports Medicine Exercises (NASM) corrective exercise in male employers with UCS in the Karbala province's sports office was the main purpose of this research as measured by alignment (position of the scapula, head, and neck, shoulder, and thoracic spine, shoulder pain, and disability).

## MATERIALS AND METHODS

### Study design

In this parallel-group randomized controlled trial, the impacts of 8-week NASM and traditional exercises were compared. The study was done at the Laboratory of Health and Sports Medicine Department, University of Karbala, Karbala, Iraq. At first, 30 participants (age:  $34.7 \pm 5.2$  years; weight:  $72.4 \pm 4.9$  Kg; height  $175.6 \pm 3.4$  cm, and BMI:  $24.7 \pm 1.1$  kg/m<sup>2</sup>) took part in the baseline evaluation method. Participants then performed the protocols for eight weeks. All of the measurements were repeated after the end of eight weeks. The study NASM protocol plan is shown in Table1, and a flow chart is shown in Fig.1, respectively.

Inclusion criteria were consisted of male gender, aged between 25–42 years old, BMI  $\leq 30$  kg/m<sup>2</sup>, affected from upper crossover syndrome, Shoulder pain in rest and functional activity for at least six months, have not participated in any rehabilitation program in the past six months, able to participate in research.

### Randomization

Participants were assigned randomly utilizing computer-generated block randomization in a 1:1 ratio, to NASM corrective exercise (n=17) or Traditional group (n=17) randomized. Participants had the right to withdraw from the study at any time.

The participants consist of 30 men with UCS. They were selected from the Karbala province's sports office, Iraq. Firstly, they were screened by observation for three main factors associated with UCS, including any postural alterations such as FHP ( $\geq 44^\circ$ ), rounded shoulder ( $\geq 49^\circ$ ), or thoracic hyperkyphosis ( $\geq 42^\circ$ ), shoulder pain, functional disability as measured by photogrammetry, Visual Analog Scale (VAS), and Nordic Questionnaire (NQ), respectively.

Individuals were excluded from the study process if they participated in other physical activity and sports that may influence the study results, having any noticeable malalignment in the pelvic girdle and lower limbs. Moreover, having a history of fracture, surgery, or joint diseases in the spine, shoulder girdle, pelvic girdle, and upper limbs, having a rotation of more than  $5^\circ$  on the forward bending test because of scoliosis (30).

### Posture assessment

A qualified and trained examiner that assessed head posture, shoulder posture, and thoracic kyphosis, was blind to the diagnosis and severity of postural deviations and their side effects. This assessment was conducted using lateral photographic technique in sagittal right views in a standing posture. Moreover, all participants were examined in the habitual, relaxed posture that is usually adopted (44). The photogrammetry method includes quantitatively assessing posture utilizing a photograph (45–47) and provides the measurement of

head posture, shoulder posture, and thoracic kyphosis angles. It is a reliable, non-invasive device of posture (45–47) that is approximately time- and cost-effective, and available for most clinicians. Participants were asked, "You will stand if the photo is taken; attempt to be natural" to avoid changing their position during an evaluation. For measuring forward head angle, forward shoulder, and thoracic kyphosis, three anatomical landmarks including the right tragus, the scapula acromion process, and the spinous process of C7 were identified and marked by removable adhesive dots (48). Participants were placed in front of a camera. The camera's tripod was located 2.7 m away from the stance situation and set at 1 m high ground level. Finally, the resultant photos were analyzed in AutoCAD using the anatomical points (44).

#### Forward head and shoulder angles measurements

The angle between the oblique line connecting right tragus to C7 and the vertical line was used for evaluating the forward head angle. Moreover, for measuring forward shoulder angle, the oblique line connecting right acromion to C7 and the vertical line was utilized. For head and shoulder postural deviations, the high value described more forward head as well as the forward shoulder.

#### Thoracic kyphosis angle measurements

Measuring the thoracic kyphosis was used flexicurve as a well-established, valid, and reliable method (49,50) that

detailed information on the method can be observed in prior investigations (30,42).

#### Shoulder pain and disability Index

The Shoulder Pain and Disability Index (SPADI) is a self-administered questionnaire that consists of two dimensions, one for pain and the other for functional activities, and requires 5 to 10 minutes for a patient to complete (51). The pain dimension consists of five questions regarding the severity of an individual's pain. Functional activities are assessed with eight questions designed to measure the degree of difficulty an individual has with various ADL that require upper-extremity use. To answer the questions, patients place a mark on a 10-cm visual analog scale for each question. Verbal anchors for the pain dimension are "no pain at all" and "worst pain imaginable", and those for the functional activities are "no difficulty" and "so difficult it required help." The scores from both dimensions are averaged to derive a total score. Table 1 lists the SPADI items (51).

Exclusion criteria were including deformity of the chest, having background respiratory, neurologic, neuromuscular, and cardiovascular diseases, vestibular defects, recent cardiac or thoracic surgery, and spinal postural alignment or upper and lower limb pathologies, leaving to attend pre- and post-test, and irregular participation (up to 3-time absence) in training sessions.

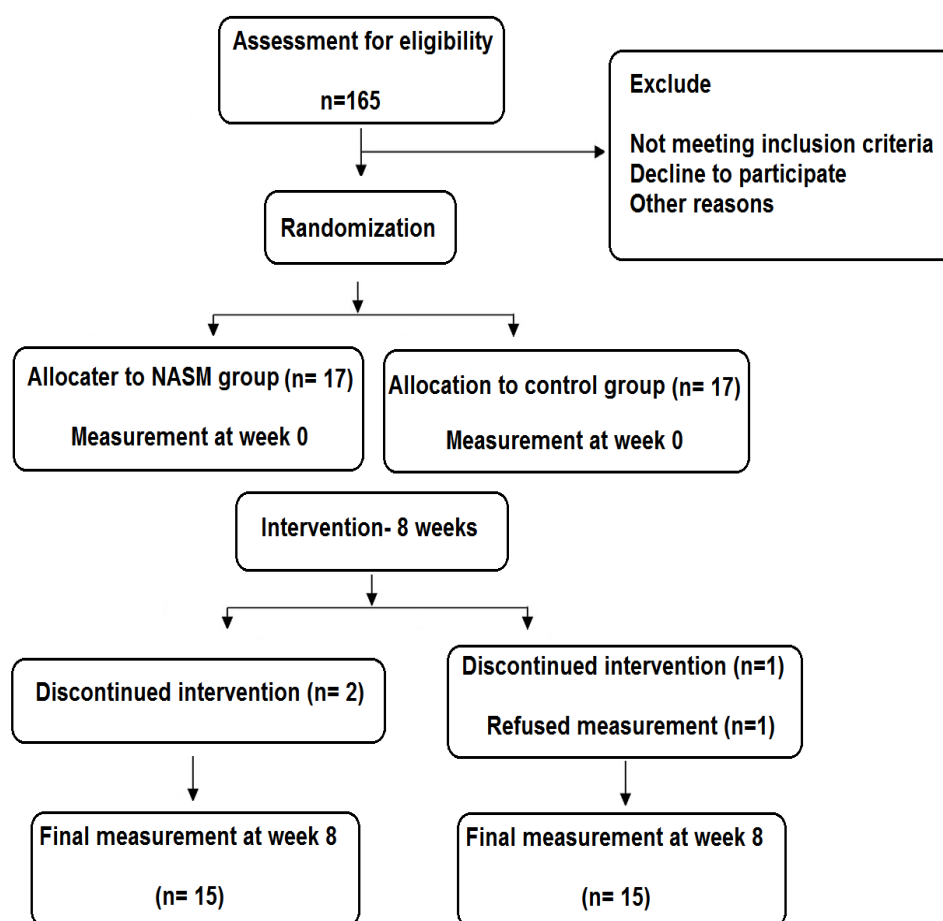


Fig 1: Study flowchart

A corrective exercise expert supervised all exercise sessions. Any other practices were not done at home by participants and were requested to withdraw sustaining poor posture.

**Table 1:** NASM exercises

Exercise	Sets	Duration		Notes	
Inhibit: Self-myofascial Release (1-2nd Week)					
Thoracic Spine	1-3	Hold on tender area for 30 seconds		Foam roll	
Latissimus Dorsi				Thera cane	
Upper Trapezius				Thera cane	
Sternocleidomastoid				Finger pressure	
Levator Scapula				Thera cane	
Lengthen (Neuromuscular Stretches) (3-4th Week)	Sets	Duration		Notes	
Sternocleidomastoid Stretch	1-3	7-10 second isometric contraction, 30-second hold		Stretching	
Levator Scapulae Stretch				Stretching	
Upper Trapezius Stretch				Stretching	
Ball Latissimus Dorsi Stretch				Using ball	
Standing Pectoral Stretch				Standing Stretch	
Erector spine				Sitting Stretch	
Abdominal complex				Using ball	
Isolated Strengthening (5-6th Week)	Sets	Reps	Acute Variables		Notes
Quadruped Ball Chin Tucks	1-2	10-15	2 second isometric hold and 4-second eccentric contraction		Deep Neck Flexors (DNF) Cervical-Thoracic Extensors Lower Trapezius Deep Cervical Flexors Cervical-Thoracic Extensors Lower Trapezius Isolated Strengthening Floor cobra
Resisted Cervical Posterior Translation (chin tucks)					
Floor Prone Scaption					
Quadruped Ball Chin Tucks					
Resisted Cervical Posterior Translation (chin tucks)					
Floor Prone Scaption					
Ball Combo I					
Erector spinae					
Integrated dynamic movement (7-8th Week)	Sets	Reps	Acute Variables	Rest	Notes
Ball Combo I w/Cervical Retraction	1-2	10-15	Slow-under control	30 sec	Using ball Integration Integration Integration
Squat to Row					
Single-Leg Romanian Deadlift					
Standing 1-Arm Cable Chest Press					

#### Traditional exercises:

The training program included stretching, stabilization, and strengthening exercises that performed (three times a week, for eight weeks) lasting 50 min (3,52–54). To ensure the adequate achievement of the exercises, exercise variation was set based on the American College of Sports Medicine (ACSM) advice (55).

#### Stretching:

Levator scapula stretching, Upper Trapezius stretching, Sternocleidomastoid stretching, Pectoralis minor stretching, Pectoralis major stretching (30 seconds for the first sessions, which were progressed five more seconds every two weeks) (11).

#### Stabilization exercises:

Deep Neck Flexors (DNF) stabilization, DNF stabilization in quadruped, Lying forward flexion, prone extension, Abduction external rotation (This exercise began with six repetitions of 2-second hold then, added to 10 repetitions of 10-second hold) (56).

**Strengthening:** Lying external rotation, push up plus, Flex ball exercise, Abduction external rotation in sitting back to the wall, Flexion in sitting back to the wall (Primary exercise loads were chosen according to body weight, though they were personalized by measuring ten repetition maximum (10RM) for each participant.

Considering participants were amateurs, the exercises started with three repetitions of 12 at 40% intensity of 10RM, enhanced by 10% every two weeks, and finished with 70% intensity of 10RM in the last sessions) (55,57).

#### Statistical Analysis

The statistical analysis was conducted with statistical software, namely SPSS version 16.0 (SPSS, Chicago, Illinois). All parameter results were assessed for each participant. Then mean and the descriptive statistics test calculated standard deviation (Mean  $\pm$  SD) in pre- and post-session. Kolmogorov-Smirnov tests were used to analyze the normality distribution. So, to compare the mean between pre and posttest data in both groups, independent samples t-test was used. Moreover, percentage change was measured as  $((\text{posttest} - \text{pretest}) / \text{pretest}) \times 100$  (2). The significance level was established at  $P < 0.05$ .

## RESULTS

### Patients' Characteristics

#### Survival Outcomes

The main researcher performed all outcome measurements at baseline and eight weeks (after intervention) in both the experimental and traditional groups. Based on the outcomes of the Kolmogorov-

Smirnov test, all measured variables of both groups had a normal distribution ( $P > 0.05$ ). Moreover, the equality of variance of the two groups in all evaluated variables was confirmed by Levene's Test ( $P > 0.05$ ). The participants' demographic characteristics, including age, height, and weight, are shown in Table 2. Table 2 shows the descriptive data associated with the calculated variables in the pre-test and post-test for both groups. According

to the finding's independent samples t-test (Table 3), the forward head angle ( $t = -4.053$ ,  $p = 0.000$ ), forward shoulder angle ( $t = -5.067$ ,  $p = 0.000$ ) and hyperkyphosis angle ( $t = 5.187$ ,  $p = 0.000$ ), shoulder pain ( $t = -3.807$ ,  $p = 0.001$ ), and functional disability ( $t = -3.969$ ,  $p = 0.001$ ) outcomes are presented significant difference after 8 weeks of NASM with traditional exercises.

**Table 2:** Mean and Standard Deviation of Demographic Characteristics of participants in the experimental and traditional Groups

Variable	group	M	p
Age	NASM	35.13±5.01	0.329
	Traditional	34.26±5.59	
Height	NASM	174.87±36.61	0.518
	Traditional	176.33±32.21	
Weight	NASM	75.40±4.74	0.887
	Traditional	77.46±5.09	
Body Mass Index	NASM	24.64±0.95	0.126
	Traditional	24.90±1.31	

**Table 3:** The changes of parameters from baseline to 8 weeks.

Test		NASM (M±SD)	Changes (%)	Traditional (M±SD)	Changes (%)	t	P
FHP (°)	Pretest	46.20±1.56	12.32	46.00±1.96	4.78	0.308	0.760
	Posttest	41.13±1.24		43.90±2.33		-4.053	0.000*
FSH (°)	Pretest	51.73±2.05	17.22	51.13±1.80	4.77	0.850	0.403
	posttest	44.13±2.58		48.80±2.45		-5.067	0.000*
Thoracic kyphosis (°)	Pretest	47.60±2.64	23.95	48.26±1.90	10.29	-0.793	0.435
	posttest	38.40±2.82		43.73±2.18		5.784	0.000*
Shoulder Pain	Pretest	44.66±7.89	74.04	43.00±7.74	14.17	0.583	0.564
	posttest	25.66±8.20		37.66±9.03		-3.807	0.001*
Functional disability	Pretest	32.66±9.23	81.44	34.33±8.42	21.17	-0.516	0.610
	posttest	18.00±5.60		28.33±8.38		-3.969	0.001*
Values are means ± SD. FHP: Forward head psture, FSH: Forward shoulder, * p < 0.001.							

## DISCUSSION

We propose to assess the effectiveness of 8-weeks of NASM corrective exercises on alignment, shoulder pain, and functional disability in a group of males aged 25-42 years with UCS. The findings reported that the FHP, FSH, and thoracic hyperkyphosis improved significantly. A similar trend was perceived about shoulder pain and functional disability. In other words, the outcomes of this study provide proof to confirm that the NASM protocol can present an optimal method for UCS and its side effects.

It is believed that it is crucial to quantify head, shoulder, and thoracic kyphosis role as all impact and is affected by numerous biomechanical, motor control, and performance variables (58). Exercise intervention can alter and correct postural malalignment. However, in review research by Hrysomallis and Goodman reports little data to confirm this theory (16). Besides, despite the broad correcting postural malalignment via exercise, there are insufficient practical documents to verify their effect, and limited is comprehended about the most efficient exercise interventions (40). As already mentioned, it seems the dependence on the traditional structural approach in the prior investigations is the most major cause that supposes that exercises must be done in

a localized and isolated way (59). The traditional structural approach for correcting postural malformations is based on local stretching and strengthening the shortened and weakened muscles, respectively. Unusually, the body is distressed with a malalignment, locally; rather, postural deviations in a segment of the spine will influence other proximal and distal segments (13,14).

NASM exercise interventions in this study were centered on the muscles involved in this syndrome and designed and implemented based on Janda's chain reaction theory and the Bruger's Cogwheel chain mechanism of poor posture (60).

Hence, regarding the notable improvement in FH angles (%12.32 vs. %4.78), FSH angles (%17.22 vs. %4.77), and thoracic hyperkyphosis angles (%10.01 vs. %4.10) of the participants in the NASM exercise intervention than traditional exercise group, data confirm the positive effect of NASM exercises on malalignment and muscle imbalance that was additionally confirmed by other investigations (14,43,61,62).

Moreover, one of the advantages of this study than others is to evaluate the side effects of the UCS. In this study, the influences of NASM exercise intervention on shoulder pain (%74.04 vs. %14.17) and functional disability



(%81.44 vs. %21.17) show significant reduction than traditional exercise group.

The trainer and athletes demand to know that static and dynamic poor posture, sustain alignment, and repetitive movements can generate dysfunction within the connective tissue of the human movement system (63–65). The body's dysfunction is treated as an injury and will start a rehabilitation process termed the cumulative injury cycle (63). For this purpose, the inhibition stage as the first phase in NASM exercises concentrates on inhibition or relaxation of overactive muscles, probably originated from repetitive movements, sustain alignment for compensating underactive muscles function (66). Myofascial adhesions and trigger points form in muscles overactive and shortened when malalignment (25,66). Inhibitive techniques perform to decrease and release tension, the over-active of neuromyofascial tissues, and overactive muscle fibers in the body (14).

Utilizing myofascial release methods generates an inhibitive response in the muscle spindles and the release of overactive and stiffed(11).

Hanten and colleagues confirmed that ischemic squeezing and static stretching in people with neck, shoulder, and upper back pain was significantly efficient at diminishing pain and irritability(67). Keeping pressure on the tender areas of tissue (trigger points) for a sustained period has functional importance that can diminish trigger point activity. Moreover, this method will then present the use of a lengthening method to provide for optimal length-tension relationships muscle via extensibility of the overactive and short muscles(13). With optimal length-tension relationships, subsequent use of corrective activation and integrated strengthening exercises will ensure an increase in intramuscular and intermuscular coordination, endurance strength, and optimal force couple relationships that will produce a proper joint play and improve the function of the human movement system. Besides, continued tissue pressure arouses mechanoreceptors to transmit afferent information to the central and autonomic nervous systems. In turn, the central nervous system response changes the muscle tonus (or decreases hypertonicity) in skeletal muscle. The autonomic nervous system response also changes global muscle tonus as well as fluid dynamics to decrease viscosity and the tonus of the smooth muscle cells located in the fascia (11,68).

UCS is usually prevalent within people who have sitting and standing posture for long times or people who use various overload patterns on their upper body. Bruger, the Swedish neurologist, defines the Cogwheel chain mechanism of poor posture (11). On the other hand, while sitting behind a desk, checking the employers' work on their desktops, and performing tasks, employees use improper postures, which lead to musculoskeletal deformations, pain, and reduction in function (69). For example, increased thoracic kyphosis during the profession is strictly associated with the head and the cervical spine's alignment and movement (14). Consequently, by guiding, teaching, and correcting the posture in working place for employees, the investigation points to the great effectiveness of the exercises (3,14,17).

We want to perform this study based on the functional approach, which is appropriately powered and uses approved result measures of UCS to examine the effects of the NASM exercises intervention on both our main and consequent results. If the NASM exercises intervention

outcomes in changing the alignment, pain, and functional ability can value for the alteration in the UCS signs. Moreover, if we find out that the NASM exercises intervention can correct a postural malalignment the same in UCS, this data could facilitate practitioners to suggest a new method for UCS to prevent or restrict UCS associated consequences. Accordingly, in the field of physical therapy and corrective exercises, numerous specialists implemented with the experience on these novelties can recognize people with UCS and further choose relevant corrective procedures to improve it and anticipate the event of secondary consequences.

Our investigation has some restrictions, including the recruitment of exclusive the society sex, which only men involved in this investigation, as because of the nature of this research it was required to assess without clothing, the men 25 to 42 years of age. Hence, the outcomes of this research will not be generalizable to all people (e.g., men aged  $\geq 25$  years) with UCS. The suggestion of this investigation is the significance of utilizing this approach for the employees who suffer from USC.

## CONCLUSION

In fact, it's been scientifically proven, NASM exercise intervention could be an efficient restoration plan for decreasing FHP, FSH, and thoracic kyphosis angles. Furthermore, the UCS and side effects could be assessed and trained for estimating the amount of any exercise interventions.

## Authors' Contribution

GHGH and RMN conceived and designed the research. MChIA performed the research. MChIA analyzed the data. MChIA completed the manuscript. GHGH and RMN revised the manuscript.

## CONFLICT OF INTEREST

All authors declare that they have no conflict of interest.

## ETHICAL STATEMENT

The study does not involve ethical problems. All participants signed an informed consent form before starting the study. Ethics approval was taken from the Ethics Committee of the Isfahan University, Isfahan, Iran and was carried out according to the Helsinki Protocol.

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