Original Article

Association between Upper-extremity Musculoskeletal Disorders and Upper Cross Syndrome among Teachers, and the Effects of NASM Corrective Exercises along with Ergonomic Intervention on their Upper-extremity Musculoskeletal Disorders

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Abstract

Background & Aims: The main objective of the current study was to evaluate the association between upper-extremity musculoskeletal disorders and upper cross syndrome (UCS) among teachers as well as the effects of NASM exercises and ergonomic intervention on their upper-extremity musculoskeletal disorders.

Materials & Methods: The Nordic Questionnaire was used for determining the prevalence of musculoskeletal disorders and the New York Test was used for determining the prevalence of UCS among 269 teachers. Among those tested, 23 participants were identified as the sample of the study, and then they were divided into an experimental group (12 participants, age 45.20 ± 8.1 years, height 178.83 ± 6.5 cm, and weight 78.3 ± 13.08 kg) and a control group (11 participants, age 44.1 ± 7.8 years, height 175.83 ± 7 cm, and weight 77.9 ± 13 kg) to go through 12 weeks of NASM exercises along with ergonomic intervention. In this study, chi-square and Wilcoxon tests were used.

Results: The prevalence rate of musculoskeletal disorders for neck was 53%, for shoulders was 41%, for back was 39%, and the prevalence rate of UCS was 43%. The results of the test showed a significant relationship between upper-extremity musculoskeletal disorders and the UCS ($p < 0.05$). Moreover, the intragroup and intergroup results of the participants showed a significant decrease in musculoskeletal disorders of the neck, shoulders, and back after administering the interventions ($p < 0.05$).

Conclusions: The findings of the study showed that NASM exercises and ergonomic intervention (as an intervention-exercise protocol) decrease upper-extremity musculoskeletal disorders among teachers.

Keywords: forward head, forward shoulder, hyperkyphosis, Nordic Questionnaire, New York Test

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Introduction

Any job has its health hazards and complications, and teaching is no exception. The work teachers do have high social value since teaching can promote economic growth, and scientific and technical development in the community (1). The prerequisite to realize these

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objectives involves a healthy workforce, both physically and mentally, along with utilizing the necessary equipment with excellent quality and quantity, as well as sufficient financial resources. Musculoskeletal disorders are a common occupational complication in teaching, and teachers as an occupational group suffer from a high prevalence rate of musculoskeletal disorders; the rate of these disorders among teachers has been reported as 39 to 95 percent. (2) These disorders affect muscles, tendons, ligaments, joints, peripheral nerves, and blood vessels, and the body parts prone to damage include upper extremities (i.e. neck, shoulders, and back). (3) (4) On the other hand, lack of muscular balance can affect the natural posture of the body and afflict the body with various types of postural disorders, sometimes causing the individual to become prone to acute and chronic damages. (5) The upper cross syndrome, which causes a wide variety of changes in the upper quarter of the body, occurs in the neck area and the shoulder girdle. This syndrome is often accompanied by forward head posture, forward shoulder posture, rounded scapulae, and chest kyphosis disorders. (6) It is rare for a single part of body to get afflicted with a disorder; rather, generally a disorder in one part of the backbone will affect its other parts. The interdependency of effects of disorders in various parts of the body on other parts must be accurately considered during treatment. Therefore, when evaluating postural disorders and abnormalities of the backbone, the body must be considered as a whole. (6) For instance, increased back kyphosis during work is closely related to the displacement of the head and neck parts of the backbone (7), and the upper cross syndrome is related to neck pain in computer users. (8) Moreover, in a study in China, sitting for too long, improper posture, and slouching were significantly related to pain in neck, shoulders, and the lower back among teachers. (9) In addition, the majority of office workers in Thailand with improper posture reported increased pain in the neck area. (10) In general, research shows that school teachers are prone to musculoskeletal disorders (MSD's). Therefore, Erich investigated the issue of MSD and postural risk factors among teachers and emphasized the broader utilization of ergonomic principles and interventional strategies. (2) Moreover, he suggested regular athletic exercises as a protective factor for mitigating and ultimately preventing these conditions. (11) National Academy of Sports Medicine (NASM) has recently proposed a new corrective exercise protocol, which includes four phases, i.e. inhibit, lengthen, activate, and integrate stages. Hence, since it seems that limited studies evaluated the prevalence rate of MSD and related posture with an emphasis on corrective work out and exercises and interventions for reducing such disorders among teachers, and considering the new spectrum of corrective exercises and the considered exercises, the main objective of the current study was to investigate the association of upper-extremity musculoskeletal disorders and upper cross syndrome as well as the effects of NASM exercises along with ergonomic intervention on the upper-extremity musculoskeletal disorders among teachers.

Methodology

The Sample:

The current research is a semi-experimental study. The statistical population in this study includes all the primary school teachers working in schools around Fasa City. After coordinating with the administrative and research management office (ethical code of $IR.UI.REC.1397.104$), the researchers were established in corrective exercise hall of the Teaching and Education Organization in order to administer corrective exercises and ergonomic interventions. The Nordic Questionnaire was used for determining the prevalence rate of musculoskeletal disorders, and the

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New York Test was used for determining the prevalence rate of upper cross syndrome among 269 primary school teachers.

The Nordic Questionnaire:

This questionnaire consists of two parts: (a) general questionnaire, and (b) specialized questionnaire. The objective of the general questionnaire is to perform a generic examination and it involves the symptoms of the disorders in the whole body. The general questionnaire records such data as age, gender, weight, height, and right and left-handedness. The specialized questionnaire performs a deep analysis of specific parts of the body such as the neck, shoulders, and back. This standard questionnaire has been widely used in Denmark, Finland, Norway, and Sweden, and it provides useful and reliable information on the symptoms of musculoskeletal disorders, which can be used for deeper examinations, or decision-making for corrective interventions. (12).

The New York Test and Method of Measurement:

This test evaluates 13 different body postures, among which 11 postures are related to evaluating the backbone, and the observations on the posture of the body are usually recorded on a checkerboard in this test. In this study, three posture evaluations for neck, shoulders, and back were utilized, in a way that for each posture, three images were provided, with each having a score. The left-side image, depicting the natural posture of the body, has a score of 5; the middle image, depicting mild disorder, has a score of 3; and the right-side image, depicting severe abnormality, has a score of 1. The examiner selected the image which best depicted the body posture of the participant. Simultaneous utilization of the New York Test and the checkerboard both facilitates the diagnosis of the disorder and increases the accuracy of measurements. Therefore, both of these methods were used simultaneously at the screening stage. (13) Those obtaining scores of 3 or 1 for all three postures of forward neck, forward shoulders, and kyphosis were selected as individuals suffering from upper cross syndrome.

After determining the prevalence rate, 23 of the non-athletic male teachers, suffering from upper-extremity musculoskeletal disorders, were selected as the statistical sample using targeted convenient sampling. After completing the consent form, they were divided into the experimental group (NASM corrective exercises along with ergonomic intervention) and the control group. The criteria for elimination included having pathological symptoms such as a history of breaking bones, surgery, or joint diseases in the backbone, osteoporosis, acute rheumatoid arthritis (RA), blood-related diseases, congestive heart failure, malignancy, severe skin allergies, and athletic activity.

Exercise Program:

The prescribed corrective program lasted for 12 weeks, with three sessions a week, each session for 45 to 60 minutes. In the initial sessions, the exercises were of lower intensity, repetitions, frequency, and duration. For the later sessions, these factors were increased in frequency and difficulty gradually based on the abilities of the participants in a way that the principles of exercise could be met. The intensity of stretching exercises was to the threshold of pain and the intensity of strength exercises was to the fatigue level of the individual. All the exercises were administered based on work-out principles, their gradual increase in intensity, duration, the principle of adding loads, and the movement patterns of the involved exercise (6).

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Table 1.

Upper Cross Syndrome Exercise (1-4th Week)					
INHIBIT					
Exercise: Self-Myofascial Release	Sets		Duration		Notes
Latissimus Dorsi	1-3		30 sec		Thera cane & foam roll
Thoracic Spine	1-3		30 sec		Thera cane
Upper Trapezuse	1-3		30 sec		Thera cane
Sternocleidomastoid	1-3		30 sec		Thera cane
Levator Scapula	1-3		30 sec		Thera cane
Upper Cross Syndrome Exercise (5-8th Week)					
INHIBIT					
Exercise: Self-Myofascial Release	Sets		Duration		Notes
Latissimus Dorsi	1		30 sec		Thera cane & foam roll
Thoracic Spine	1		30 sec		Thera cane
Upper Trapezuse	1		30 sec		Thera cane
Sternocleidomastoid	1		30 sec		Thera cane
Levator Scapula	1		30 sec		Thera cane
LENGTHEN					
Exercise: Static Stretch	Sets		Duration		Notes
Sternocleidomastoid Stretch	1-3		30 sec		
Levator Scapulae Stretch	1-3		30 sec		
Upper Trapezius Stretch	1-3		30 sec		
Ball Latissimus Dorsi Stretch	1-3		30 sec		
Standing Pectoral Stretch	1-3		30 sec		
ACTIVATION					
Exercise: Isolated Strengthening	Sets	Reps	Tempo	Rest	Notes
Quadruped Ball Chin Tucks	1-2	10-15	4/2/2	0	Deep Cervical Flexors
Resisted Cervical Posterior Translation (chin tucks)	1-2	10-15	4/2/2	0	Cervical-Thoracic Extensors
Floor Prone Scaption	1-2	10-15	4/2/2	0	Lower Trapezius
Upper Cross Syndrome Exercise (9-12th Week)					
LENGTHEN					
Exercise: Static Stretch	Sets		Duration		Notes
Sternocleidomastoid Stretch	1-2		30 sec		
Levator Scapulae Stretch	1-2		30 sec		
Upper Trapezius Stretch	1-2		30 sec		
Ball Latissimus Dorsi Stretch	1-2		30 sec		
Standing Pectoral Stretch	1-2		30 sec		

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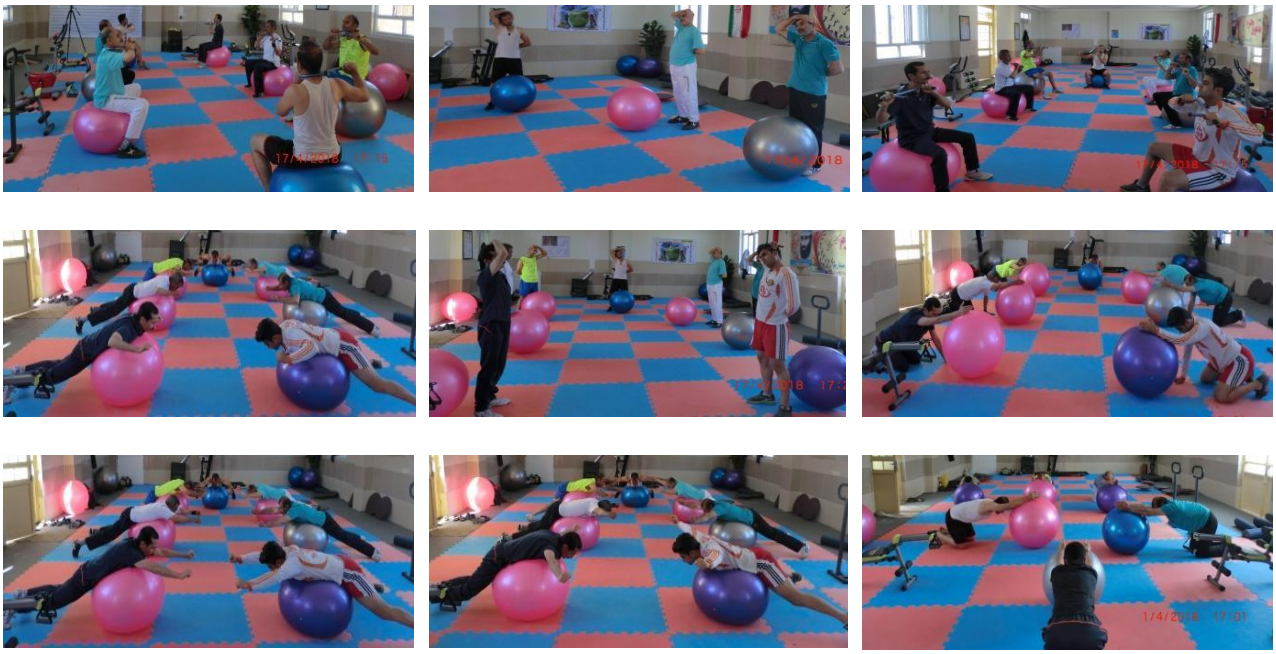
ACTIVATION					
Exercise: Isolated Strengthening	Sets	Reps	Tempo	Rest	Notes
Quadruped Ball Chin Tucks	1-2	10-15	4/2/2	0	Deep Cervical Flexors
Resisted Cervical Posterior Translation (chin tucks)	1-2	10-15	4/2/2	0	Cervical-Thoracic Extensors
Floor Prone Scaption	1-2	10-15	4/2/2	0	Lower Trapezius
Ball Combo I	1-2	10-15	4/2/2	0	
INTEGRATED DYNAMIC MOVEMENT					
Exercise:	Sets Rest	Reps	Tempo	Rest	Notes
Ball Combo I w/Cervical Retraction	1-2	10-15	Slow	30 sec	
Squat to Row	1-2	10-15	Slow	30 sec	
Single-Leg Romanian Deadlift	1-2	10-15	Slow	30 sec	
Standing 1-Arm Cable Chest Press	1-2	10-15	Slow	30 sec	



Ergonomic Intervention:

These interventions were selected based on the protective and health directives of the Labor Ministry according to the physical status, muscular strength, and body movements. This was done in order to avoid unnecessary or excessive stress on muscles, joints, tendons, and the cardiovascular and respiratory systems. (14) Ergonomic interventions utilized in this study included the following:

I. Avoid leaning on the desktop and relying on the front part of the desk (in order to maintain the S-shaped curve of the backbone);
II. Support was created for the lower back;
III. The natural posture of the body in neck and back areas was maintained and leaning forward, backward, or to the sides was avoided;
IV. A footrest or support for feet was utilized;

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V. Prolonged standing or sitting in the same posture was avoided;

VI. When teaching and writing on the board, the hand was placed in a way that less pressure was exerted on the shoulders (not too high and not too low);

VII. Checking the homework of students behind their desks was avoided.

Results

The results of the study showed that the prevalence rate for musculoskeletal disorders related to neck was 53%, for musculoskeletal disorders related to shoulders was 41%; for musculoskeletal disorders related to back was 39%, and the prevalence rate of upper cross syndrome among teachers was 43%. Moreover, from the viewpoint of the participants, a large percentage of these disorders were related to the nature of their career, in a way that 60% of the teachers reported working in such a work environment as the main risk factor for inducing upper-extremity musculoskeletal disorders (Table 2).

Table 2: Data Obtained from General Nordic Questionnaire and the New York Test

Disorders and Abnormalities	Male		Female		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Upper Crossed Syndrome	76	46%	43	41%	119	43%
Musculoskeletal Disorders of the Neck	80	48%	63	60%	143	53%
Musculoskeletal Disorders of the Shoulders	64	39%	48	45%	112	41%
Musculoskeletal Disorders of the Back	62	37%	45	42%	107	39%

Chi-square test was used for evaluating the relationship between upper cross syndrome and upper-extremity musculoskeletal disorders, and the results showed a significant relationship. In other words, among those suffering from upper cross syndrome, 69% were also suffering from musculoskeletal disorders of the neck, 56% were also suffering from musculoskeletal disorders of the shoulders, and 54% were also suffering from musculoskeletal disorders of the back ($p < 0.05$) (Table 3).

Table 3: The Relationship between Upper cross syndrome and Upper-Extremity Musculoskeletal Disorders

Pearson's Chi-Square	Neck Pain		Shoulder Pain		Back Pain	
	Yes	No	Yes	No	Yes	No
UCS=109	83	36	62	57	59	60
USC=100%	69%		56%		54%	
p	0.000		0.002		0.004	

Furthermore, in order to evaluate the effects of NASM corrective exercises along with ergonomic intervention on upper-extremity musculoskeletal disorders, the Wilcoxon test was used, and its results are presented in Table 4.

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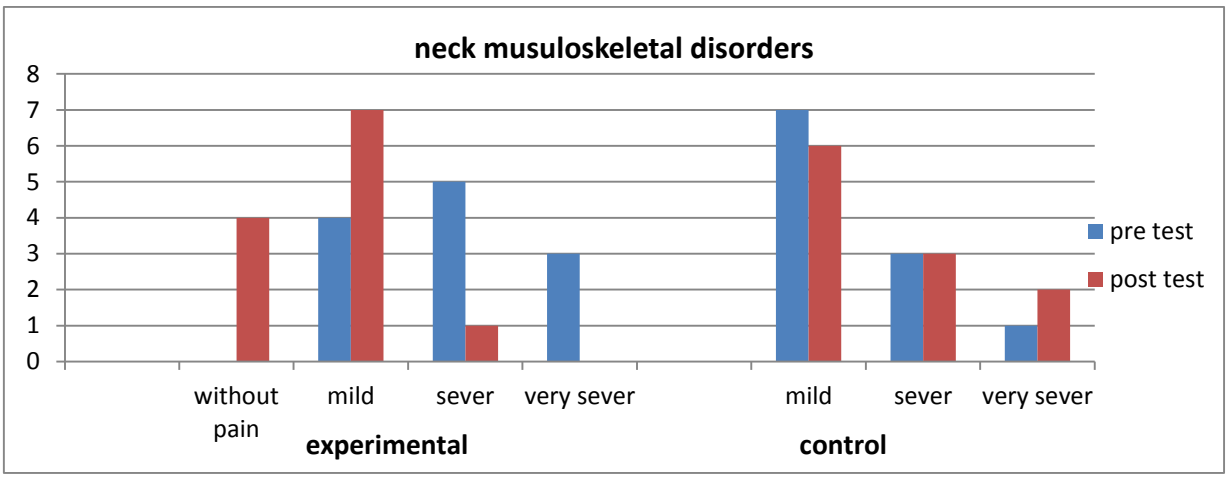
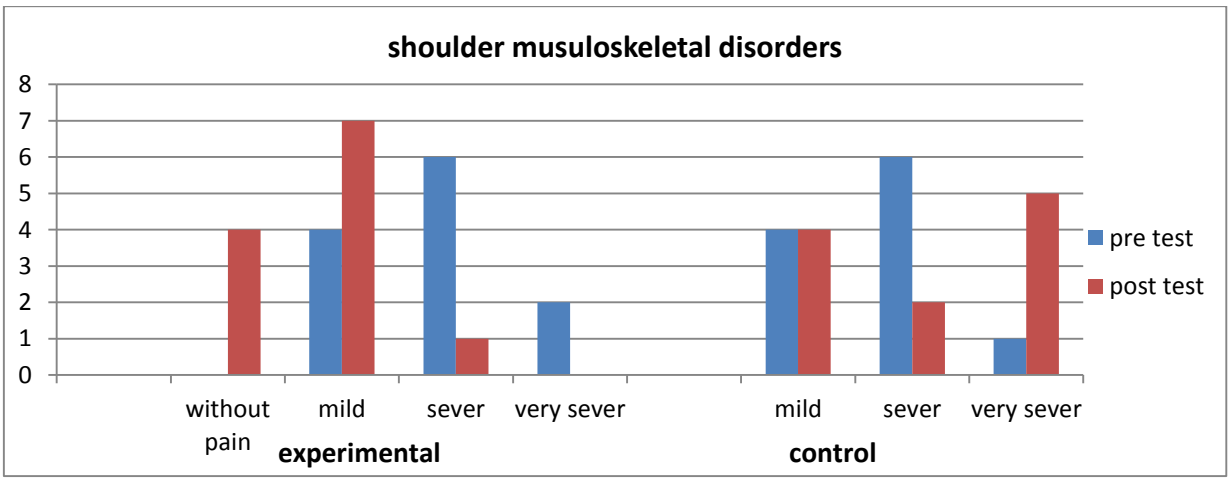
Table 4: Effects of NASM Corrective Exercises with Ergonomic Intervention on Upper-Extremity Musculoskeletal Disorders

Variables		df	z	P
Intragroup	Musculoskeletal Disorders of the Neck	11	−3.27	0.001
	Musculoskeletal Disorders of the Shoulders	11	−3.127	0.002
	Musculoskeletal Disorders of the Back	11	−3.223	0.001
Intergroup	Musculoskeletal Disorders of the Neck	21	−3.041	0.002
	Musculoskeletal Disorders of the Shoulders	21	−3.093	0.002
	Musculoskeletal Disorders of the Back	21	−2.838	0.011

Musculoskeletal Disorders of the Neck, Shoulders, and Back:

There was a significant difference regarding musculoskeletal disorders of the neck, shoulders, and back before and after the 12-week NASM corrective exercise along with ergonomic intervention program ($p<0.05$).





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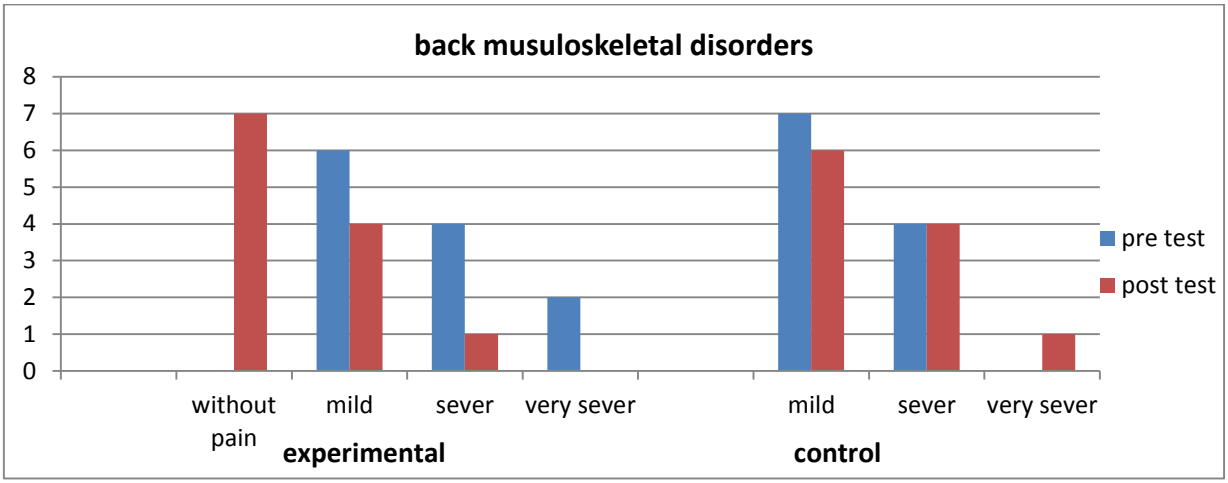

Figure 1.

Discussion and Conclusions

The current study was carried out in order to evaluate the association of upper-extremity musculoskeletal disorders and upper cross syndrome, as well as the effects of NASM corrective exercises along with ergonomic interventions on the upper-extremity musculoskeletal disorders of teachers. Based on the obtained results, the last 12-month prevalence rate of musculoskeletal disorders in neck area was 53%, in shoulders area was 41%, in back area was 39%, and that of the upper cross syndrome was 43%, which indicates a high rate of musculoskeletal disorders among teachers. Moreover, from the viewpoint of the participants, a high percentage of these disorders are due to the nature of their occupation, i.e. 60% of the teachers reported working in such a work environment as the main factor inducing upper-extremity musculoskeletal disorders. These results are in line with the findings of Addela Mumtaz (15), Ojukwu (16), Damayanti (17), Solis-Soto (18), Erich (2,11,19), Liping (20), Cheng (3), and Chiu (21).

The main point deduced from the above-mentioned reports is that any occupational activity is accompanied by its specific musculoskeletal disorders. Studies on the activities of teachers showed that they spend a significant portion of their workday on activities that affect their physical movements and postures (3); activities such as bending the neck, forward-head posture, significant bending on the head downward for reading, checking homework, and writing on the board. (21) Considering the improper postures teachers have in these situations, such as prolonged sitting, static posture, improper back posture, raising shoulders in relation to the body, relying on arms and hands while standing, and performing repetitive and fast movements in the classroom, they will easily get afflicted with musculoskeletal disorders. (9,17).

In addition, the results showed that there was a significant relationship between upper cross syndrome and musculoskeletal disorders. In other words, among 109 teachers suffering from upper cross syndrome, 69% were also suffering from musculoskeletal disorders of the neck, 56% were also suffering from musculoskeletal disorders of the shoulders, and 54% were also suffering from musculoskeletal disorders of the back. The results of the study are in line with the results of Silva et al., (22) and Boland et al. (23) with regards to the relationship between forward-head posture and neck pain; the studies of Gregil Morris et al., (24) and Mirbagheri et al. (25) with regards to the relationship between kyphosis and pain between the two scapulae and in the back area; and the results of Zavar Tafakhor

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(8) with regards to the relationship between upper cross syndrome and neck pain in computer users. Moreover, in a study carried out in China, prolonged sitting, improper posture, and curved back posture were shown to have a significant relationship with pain in neck, shoulders, and lower back area of teachers. (9) In addition, the majority of office workers in Thailand who had an improper posture reported pain in the neck (10).

Based on the observations of the researcher in the working environment of the participants, forward-head posture and kyphosis when sitting behind a desk and when checking students' homework, as well as forward-shoulders when writing on the board and when checking exam sheets were identified, and holding such postures for prolonged periods can lead to the upper cross syndrome. In the upper cross syndrome, the shortening of the trapezius muscles and the backside muscles used for elevating shoulders is accompanied by shortening of the small and large pectoral muscles, as well as the weakening of the deep neck flexors and middle and lower trapezius muscles. This asymmetric pattern induces joint dysfunction, particularly in the atlanto-occipital joint, the neck-back joint, and the glenohumeral (shoulder) joint, which is often accompanied by muscular pain. (26) Therefore, deviating from what is considered as the natural posture of the body and the backbone will lead to imbalance or unnatural stretching, followed by muscular spasms and pain in the musculoskeletal system (27).

Furthermore, the results showed that NASM corrective exercises along with ergonomic intervention improve musculoskeletal disorders of the neck, shoulders, and back area of the participants. The exercises used in this study were designed in such a way that the individual can perform them in an active and dynamic manner. Since the NASM exercise protocol significantly decreases the musculoskeletal disorders of the participants in the experimental group, it seems that with regards to the duration, the number of repetitions, the intensity, and the conditions of work-out, the exercises have been effective. The effectiveness of NASM exercises has also been shown in studies conducted by Roshani et al. (28), Rostami Zalani et al. (29), and Bagherian et al. (30). The difference between NASM exercises and other similar exercises is related to the inhibition phase. Studies showed that in the muscles shortened during abnormalities, myofascial adhesions and trigger pints are crated (31). The objective of inhibition techniques is to relieve the stress or reduce the excessive activity of the neural-muscular-fascial tissue of the body. The myofascial relief techniques lead to the creation of an inhibitory response in muscle spindles and the relief of hardened and shortened muscles (6). Using foam rollers and trekking are very effective methods for this phase. In this study, myofascial relief exercises were carried out using foam rollers and trekking, which may be one of the reasons for the effectiveness of this exercising protocol. Along with the prescribed corrective exercises, the necessary ergonomic interventions were also provided. The ergonomic interventions reduced the contact level with risk factors and significantly contributed to the effectiveness of the corrective exercises. Based on the observations of the researcher in the work environment of the participants, forward-head posture and kyphosis posture when sitting behind a desk and when checking students' homework, as well as forward-shoulders when writing on the board were identified. Therefore, the prescribed interventions were mainly aimed at mitigating these undesirable postures of the teachers, which were corrected through verbal training and movement correction.

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