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The Effect of Self-management Exercises on Neck Pain and Head and Neck Angles among Iranian University Employees: An Interventional Study

Sara Tabanfar[1], Ali Safari Variani[2], Seyvan Sobhani[3], Sakineh Varmazyar[4*]

1. M.Sc in Occupational Health Engineering, Dept. of Occupational Health Engineering, Faculty of Health, Qazvin University of Medical Science, Qazvin, Iran.
2. Associate Prof., Dept. of Occupational Health Engineering, Faculty of Health, Qazvin University of medical sciences, Qazvin, Iran.
3. M.Sc in Occupational Health Engineering, Dept. of Occupational Health Engineering, Faculty of Health, Qazvin University of Medical Science, Qazvin, Iran.
4. Associate Prof., Dept. of Occupational Health engineering. Social Determinants of Health Research Center and Research Institute for Prevention of Non-Communicable Diseases. Faculty of Health, Qazvin University of Medical Sciences, Qazvin, Iran.

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*** Corresponding author:**
Sakineh Varmazyar,
E-mail:
svarmazyar@qums.ac.ir

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Abstract

Background: Long-term computer use as an ergonomics risk factor can generate musculoskeletal disorders, especially in the neck. This study aimed to investigate the effect of a self-management exercises intervention on both neck pain, and head and neck angles among university employees in 2021.
Materials & Methods: This experimental study was performed on 85 university staff (experimental group (N=42) and control group (N=43)) who were randomly selected based on inclusion criteria from the list of Qazvin University of Medical Sciences (Iran) employees. The experimental group did the exercises for 12 weeks with five 15-minute sessions per week. The severity of neck pain was determined using the Visual Analog Scale (VAS). Head and neck angles were measured at baseline and after 12 weeks using photogrammetry and Kinovea software in two postures (reading and typing).
Results: About 60% of the participants in the experimental group reported moderate and severe neck pain, decreasing to 26.2% after the intervention. The score of neck pain intensity in the experimental group decreased in the range of 1.15-1.75. The head and gaze tilt angles and head forward position after the intervention in the experimental group showed a significant decrease. Also, the head tilt angle was significantly increased after the intervention.
Conclusions: The results showed that exercises could be beneficial in improving the posture of the head and neck, which caused reducing the severity of neck pain among computer users.

Keywords: Computer, Ergonomics, Exercise, Head, Neck Pain, Posture

Introduction

Recently, due to the growth of industry and technology, electronic devices, including computers, have become widespread in many societies and at different ages [1]. Studies have shown that long-term use of computers causes severe injuries to the upper extremities [2]. Long-term computer use leads to a static posture for a long time, especially in the neck and shoulders [3]. Evidence from ergonomics research shows that the prevalence of neck pain in computer users varies from 15% to 70%, depending on the type of computer work. computer users are 2 to 3 times more likely to have neck pain [4-6].

Employees are prone to musculoskeletal disorders due to sedentary lifestyles, awkward posture, and repetitive activities [7-10]. The most common musculoskeletal disorders in office environments are neck pain [11]. Basakci Calik et al. (2022) state that 65.2% of employees have experienced neck pain in the last 12 months. [12]. Internationally, the prevalence of neck pain in employees is reported to be 45-63%. Also, in a study conducted on Iranian employees in 2017, the prevalence of neck pain during the last six months has been estimated at 41% [13]. With the increasing use of computers for scientific or professional purposes, neck pain has become the most common disorder in extensive computer users' employees [14-16]. Employees perform various activities during computer use, such as typing, reading, and writing, and spend a significant amount of time sitting with a forward head posture. The forward head posture is a risk factor for neck pain, which is twice as common as in other occupations [15]. A study in South Africa has shown that for every 1-degree increase in the angle of inclination of the head, the neck pain scores of individuals increased by 0.22 [17].

An important issue for a healthy life is physical activities that are crucial for maintaining the proper functioning of the musculoskeletal system [18]. Physical activities and exercises are among the main factors in the care and treatment of acute and chronic pain, which have always been suggested as ways to treat musculoskeletal pain [19]. Based on studies, exercise in the neck and shoulders is useful as a treatment for pain relief and improved function [19].

Many studies have focused on the effect of exercises on neck pain in employees; however, there is conflicting evidence of their benefits [8, 20]. They primarily have been performed at artificial or simulated workstations [21, 22], while the present study has been conducted at the individual workstation. Limited studies on the effect of self-management corrective movement exercises on neck pain intensity and head tilt, neck tilt, gaze angle, and the change in the forward head posture have been done in various positions among employees, while the present study examines these variables in different work postures. Therefore, given the high prevalence and costs of health care, especially in high-risk populations such as employees [23], the present study seems necessary. Accordingly, this study aims to investigate the impact of self-management exercises intervention on neck pain and head and neck angles among Qazvin University of Medical Sciences employees in the 2021 year.

Materials and Methods

This experimental study was approved in 2021 by the university ethics committee with the code IR.QUMS.REC.1399.374. Given the prevalence of neck discomfort in previous studies [24], the sample size was estimated to be 54 (Equation 1). Due to the availability of sufficient samples, 124 employees were willing to cooperate, some of whom were excluded based on inclusion criteria, and finally, 85 persons remained. Participants who matched the inclusion criteria were randomly assigned to experimental or control groups (experimental; n=42, and control; n=43).

Formula 1.

$$N = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 \times [(S_1^2) + (S_2^2)]}{(\mu_1 - \mu_2)^2}$$

α: Error probability of type I
β: Error probability Type II
S1: standard deviation in the first group (case group)
S2: standard deviation in the second group (control group)
μ1: Mean in the first group (case group)
μ2: Mean in the second group (control group)

The formula for determining the sample size Inclusion criteria were having at least one year of work experience, one year of using a computer, one hour per day of using a computer, and a body mass index ≤ of 25 kg/m2, as well as studying less than 3 hours per day, using a tablet, laptop and console less than 3 hours per day, carrying a bag weighing less than 10% of a person's body weight, and suffering from mild to high neck pain intensity.

Exclusion criteria were using more than 1 month of leave due to illness in the last year, taking sedatives, having congenital and developmental diseases in the head and neck, neuromuscular disorders in the neck, inflammatory diseases in the neck, problems in the cervical vertebrae, a history of head and neck surgery, and any uncorrected vision or hearing problems, unwilling to participate in the exercises, performing sports activities simultaneously with the corrective exercises, experiencing an accident and injury in the neck for various reasons during the corrective exercises, and not performing corrective exercises for more than 2 weeks.

Demographic questionnaires and the severity of neck pain (SNP): Employees entered the study after completing the consent form. Participants completed a demographic information questionnaire (age, gender, height, weight, and work experience). SNP was also determined using the Visual Analog Scale (VAS) [25]; it is a 10 cm horizontal line with 0 (painless) at 1 end and 10 (the worst pain imaginable) at the other end. The score was categorized into 1-3 mild pain, 4-6 moderate pain, and 7-9 severe pain (Fig. 1). Participants reported the pain level by drawing a circle around the numbers[26].

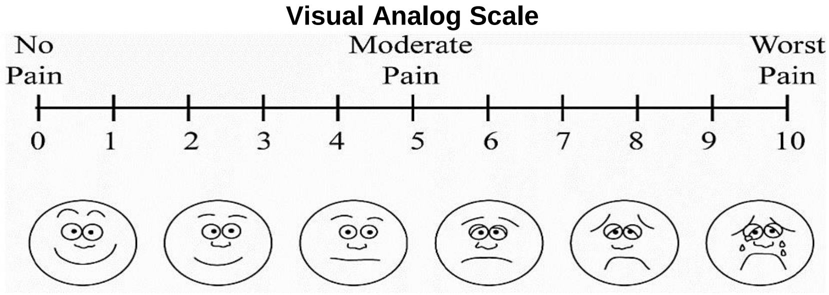

Fig. 1. Visual measuring instrument for neck pain intensity

Measurement of head and neck angles: The neck (a) and head tilt (b) angles, the gaze angle (c), and the change in the forward head posture (D) were measured using photogrammetry (measuring angles in a photo) (Fig. 2) [27]. Photogrammetry is a simple and objective measurement method with high reliability. Head and neck positions can be measured reliably and continuously using photogrammetry [27, 28]. In this section, the position of the head and neck spine was measured by taking a photo of the side view [28]. In this method, the right earlobe tragus, right eye corner, and spinous appendage of the C7 vertebra were first marked to determine the head and neck postures on the sagittal plane with an anti-allergy marker [28]. In order to determine the location of the C7 vertebra, participants were asked to bend and straighten their heads 3 times, and by touching the thorn-like part, the C7 vertebra was identified at the end of the neck vertebrae [2]. All markers were placed on the dominant side of the people and were not removed until the end of the work. Photographs were taken from the dominant side of the person [28]. To take pictures, the camera was placed on a tripod at a distance of 0.8 meters from the chair in which the person was seated. The axis of the camera lens was perpendicular to the person's sagittal plane at a height corresponding to the level of the spiny appendage of the C7 vertebrae, so that all anatomical markers were recognizable in one image. After 10 minutes of use, the lateral photogram was recorded at 2 repetitive postures, including 1) typing and 2) reviewing letters, or reading, in a sitting position at the workstation. A 2-minute rest period was considered between experiments to prevent muscle fatigue [29].

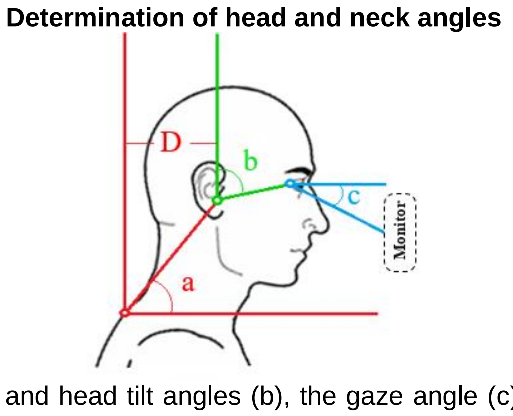

Fig. 2. How to determine the neck (a) and head tilt angles (b), the gaze angle (c), and the change in the forward head posture (D) [27]

After photogrammetry, the photo was transferred to the computer, and the angles and the rate of change in the forward head posture were determined using the Kinovea software version 0.8.15; its reliability has been reported in studies [2, 30].

Implementation of the self-management corrective exercises protocol: A corrective movement specialist prepared the protocol of corrective exercises based on similar previous valid scientific articles [31].

The protocol consisted of 10 exercises that affected the Deep Cervical Flexor (DCF) muscles, rhomboids, middle and lower trapezius, left and right neck muscles, and pectoralis (Table 1) [16, 31]. The experimental group received an educational pamphlet, a PDF file, a video on how to perform corrective exercises, a note table of the number of days and times of exercise per week, and instructions on how to perform correct movements. In contrast, no intervention was performed in the control group. Exercises were designed for 12 weeks, with five 15-minute sessions per week; thus, they were applicable at work and home [26, 32, 33]. The reason for choosing 12 weeks for intervention was similar research in this field and proper access to samples [5, 34]. The participants were contacted by telephone or text message at the end of each week and on pre-determined days to monitor and encourage exercise performance and answer questions about the correction exercise protocol during the study [20]. At the end of 12 weeks of exercise, pain intensity, angles, and a change in head position were re-determined in both groups.

Table 1. Examples of corrective exercises protocol [16, 31]

No.	Exercise	Picture	1RM	Week	Set repetition	Rest
1	Scapulothoracic (pectoralis - partial)		BW	12	FS: 20 R SS: 20 R TS: 20 R	20se
2	Cervical flexor		BW	12	FS: 15 R SS: 15 R TS: 15 R	15se
3	Scapulothoracic (middle and lower trapezius)		BW	12	FS: 10 R SS: 10 R TS: 10 R	10se
4	Scapulothoracic (rhomboid, middle and lower trapezius)		BW	12	FS: 10 R SS: 10 R TS: 10 R	10se

Abbreviations: BW= Body weight; FS= First Set; R= Repetitions; SS= Second Set; TS= Third Set

The natural distribution of each variable, by the skewness and kurtosis of the data, was examined. In addition, an independent t-test was used to evaluate the similarity of the two groups in the variables of age, height, weight, body mass index, and work experience. Paired t-test was used to compare the severity of neck pain and angles before and after the intervention in the two groups. All analyses were performed using SPSS software version 24. The significance level in the present study was considered less than 0.05.

Results

Information of participants: The mean age of the experimental and control groups was 41.74 ±7.55 and 42.53 ± 8.04 years, respectively. The results of data normality showed all variables to have a normal distribution. A comparison of variables, including age, height, weight, body mass index, and work experience, between the two groups showed no statistically significant difference (Table 2).

Table 2. Demographic information and comparison of statistical indices of variables between the two groups based on independent t-test

	Experimental group(n=42)			Control group (n=43)			
Variable \ Index	Mean ± SD	Max	Min	Mean ± SD	Max	Min	p
Age (year)	41.74±7.55	57	29	42.53±8.04	58	28	0.448
Weight (kg)	65.94±8.00	80	52	66.00±8.17	81	52	0.948
Height (Cm)	166.33±9.38	186	145	168.49±7.99	189	156	0.294
BMI (kg/m^2)	23.76±1.27	25	20.90	23.16±1.46	25	20.30	0.174
Work experience (year)	16.36±6.76	29	6	16.07±6.95	28	6	0.691
Gender: Male	17			18			
Gender: Female	25			25			

The severity of neck pain before and after intervention: The percentage of each type of qualitative SNP, in both groups, before and after the intervention is shown in Fig. 3.

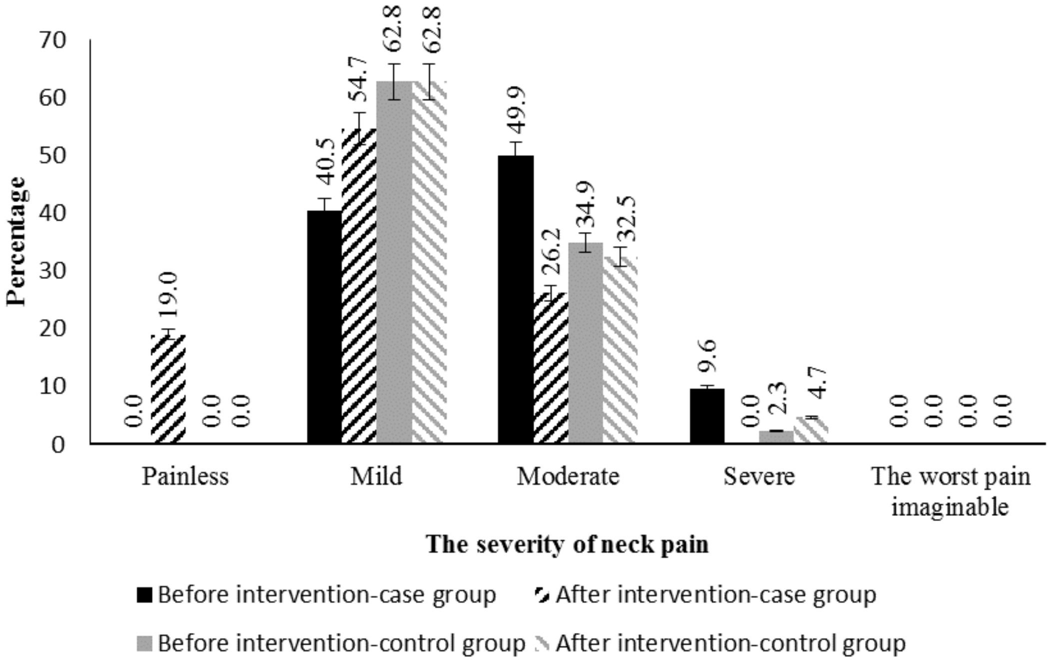

Fig. 3. Qualitative SNP in the experimental (n=42) and control (n=43) groups before and after the intervention

A comparison of the severity of neck pain in the groups before and after the intervention was performed by paired t-test. According to Table 3, the mean neck pain intensity in the experimental group was 3.83, which decreased to 2.38 after the intervention; this decrease was also statistically significant (p=0.008). In contrast, there was no significant difference in this parameter in the control group (p=0.058).

Table 3. Results of the severity of neck pain using paired t-test

Group	Variable	Intervention	mean± SD	t	p
Experimental	SNP	Before	3.83±2.12	12.2	0.008*
		After	2.38±1.82		
Control	SNP	Before	3.00±1.78	-1.95	0.058
		After	3.09±1.75		

*: P-value < 0.05

The neck and head angles before and after intervention: The angles of head tilt, neck tilt, and the gaze, as well as the change in the forward head position in two different postures (reading and typing) in the experimental and control groups, before and after the intervention, was investigated by paired t-test. The results showed all variables measured after the experimental group intervention were statistically significantly different from those before the intervention; however, these values did not show a significant difference in the control group (Table 4).

Table 4. Results of head and neck angles in the experimental (n=42) and control (n=43) groups before and after the intervention using paired t-test

Group	Posture	Variable	Intervention Before Mean±SD	Intervention After Mean±SD	t	p
Experimental	Reading	Head tilt	102.26±8.46	92.63±5.43	8.53	0.021*
		Neck tilt	33.07±8.61	41.97±8.64	-7.84	0.012*
		Gaze angle	24.05±6.24	18.27±4.58	8.50	0.014*
		Forward head posture	12.86±2.42	10.84±2.01	9.86	0.016*
	Typing	Head tilt	109.68±17.79	93.95±8.54	6.96	0.020*
		Neck tilt	19.54±5.18	36.16±6.74	-12.52	0.003*

		Gaze angle	51.61±9.74	36.07±7.9	10.50	0.009*
		Forward head posture	14.77±2.02	12.11±1.75	13.9	0.016*
Control	Reading	Head tilt angle	102.15±8.30	103.02±8.35	-1.68	0.099
		Neck tilt angle	32.77±6.60	32.21±6.40	1.40	0.169
		Gaze angle	25.76±6.82	26.64±7.13	-1.69	0.098
		Forward head posture	13±2.06	13.05±2.08	-1.38	0.175
	Typing	Head tilt angle	120.20±8.15	120.77±7.81	-1.34	0.185
		Neck tilt angle	18.17±4.77	17.67±4.61	1.82	0.076
		Gaze angle	52.09±8.83	52.69±8.86	-1.27	0.210
		Forward head posture	15.77±1.89	15.81±1.91	-1.48	0.144

*: P-value < 0.05

Improvement of the SNP and the head and neck angles after intervention: The mean intensity of quantitative neck pain in the experimental group with a decrease of 1.15-1.75 was in the category with mild pain intensity. The values of improvement in the angles of the neck, head, and gaze, as well as the change in the forward head after intervention in the experimental group, are given in Table 5. Among the angles measured in the experimental group, the most improvement was in the mean neck and head tilt angles in typing posture, which increased to 16.62 and decreased to 15.73 degrees, respectively.

Table 5. The comparison of improvement of SNP and head and neck angles in the experimental group (n=42) before and after the intervention

Variable	Posture	Before intervention	After intervention	Mean differences	+Low and high range difference
		Mean ±SD	Mean ±SD		
SNP	-	3.83 ± 2.12	2.38 ± 1.82	-1.45	1.15-1.75
Head tilt	Reading	102.26 ± 8.46	92.63 ± 5.43	-9.63	6.6-12.66
	Typing	109.68 ± 17.79	93.95 ± 8.54	-15.73	6.48-24.98
Neck tilt	Reading	33.07 ± 8.61	41.97 ± 8.64	+8.9	8.87-8.93
	Typing	19.54 ± 5.18	36.16 ± 6.74	+16.62	15.06-18.18
Gaze angle	Reading	24.05 ± 6.24	18.27 ± 4.58	-5.78	4.12-7.44
	Typing	51.61 ± 9.74	36.07 ± 7.90	-15.54	13.7-17.38
Forward head posture	Reading	12.86 ± 2.42	10.84 ± 2.01	-2.02	1.61-2.43
	Typing	14.77 ± 2.02	12.11 ± 1.75	-2.66	2.39-2.93

Discussion

Findings showed that corrective movement exercises in the neck significantly reduced neck pain; thus, the mean intensity of neck pain decreased at the rate of 1.45 in the experimental group after the intervention. In addition, moderate and severe qualitative neck pain was reduced by 33.3% after the intervention. Also, one-fifth of the staff did not report any discomfort in the neck after the intervention. However, no improvement was reported in the control group. The effect of exercise on reducing neck pain among employees can be due to strengthening the neck muscles, intense flexor muscles owing to corrective exercises. DCF plays an important role in supporting and strengthening the cervical spine. Studies have shown that the rehabilitation approach can be more effective in treating cervical disorders if the deep flexor muscles are appropriately used before strengthening the neck muscles [3, 35]. In addition, exercises with continuous and gradual contraction of the deep flexor muscles of the neck increase the activity and speed of muscle activation to cope with changes in body position. This effect can improve head and neck position, pain, and function in patients with chronic neck pain [36]. Also, strengthening the shoulder girdle muscles, including the Rhomboid and middle and lower Trapezius, and stretching muscles of the Pectoralis minor, Dorsal, and Rotator cuff shoulder improve the alignment of the head and neck [37]. A study conducted by Tunwattanapong to evaluate the effectiveness of neck and shoulder stretching exercises among employees showed that neck pain significantly improved after 4 weeks of exercise in group therapy, which was consistent with the present study [8]. The result of this research was also in line with several studies conducted in this field [19, 33, 38, 39].

The mean angle of the head tilt in the two measured positions (reading and typing) showed a statistically significant improvement and a decrease in the experimental group.

Jaroenrungsup et al., with a training protocol similar to the present study, also showed that self-management corrective exercises reduced the head tilt angle, which was in line with the present study [31]. Based on the results, the highest angle of the head tilt was observed in both groups in the typing position. Corrective exercises in the experimental group reduced the mean angle of the head tilt in reading and typing postures at the rate of 9.63 and 15.73 degrees, respectively. The reduced angle means keeping the head straight and decreasing the pressure on the cervical vertebrae, thus preventing pain and injury to the neck.

The mean neck tilt angle in the experimental group in both measured postures (reading and typing) after the intervention showed a statistically significant improvement and an increase in this angle. Suvarnnato et al. showed that 6 weeks of exercise could improve neck tilt angle and muscle strength in chronic neck pain [40].

Also, the study of Szczygieł et al. on improving and increasing the neck tilt due to corrective exercises [41] was in line with the present research. The present study also showed that the most dangerous angle of the neck tilt is when typing with the keyboard, which leads to a sharp decrease in the angle and increase in the load on the cervical vertebrae, thus increasing the risk of neck problems. Also, Chiou et al. showed that, compared to the pre-typed position, the neck tilt angle after typing was significantly reduced and flexed [42]. This problem is increased when a person moves their gaze to see a document for typing by looking at the monitor and the keyboard, leading to an increased force in the tissues around the joints and increased muscle activity [21]. Therefore, due to the long working hours, corrective movement exercises strengthen the neck muscles and keep the head and neck muscles straight, reducing the head and neck angles and thus the risk of related affliction in the long term.

The results also showed that after the intervention in the experimental group, the mean gaze angle decreased significantly, which was considerable in the typing position since it is an essential task in the office. The gaze angle is closely related to the angle of the neck tilt [21]. Therefore, correcting and reducing its angle leads to correcting the cervical spine position, which, in turn, improves the neck and head tilt angle and reduces the forward head position; as a result, it reduces the incidence of neck pain. So far, no study has examined the effect of corrective movement exercises on the gaze angle at the two postures of typing and reading.

Based on the present study, the mean change in forwarding head position in the experimental group in the two measured postures (reading and typing) had a statistically significant decrease and improvement compared to before the intervention. Other studies also have shown that a course of neck correction exercises improves forward head posture [32, 36]. Szczygieł, examining the effect of 4 weeks of neck and back muscle training on head position, showed the forward head posture to be reduced after exercise, which was consistent with the present study. Besides, Szczygiel noted that a short-term and targeted exercise program could improve head position [41]. Also, the results of this study were in line with those of other studies in this field [43, 44]. Forward head position can weaken the deep neck flexor and scapulae, such as the lower trapezius and rhombus fibers, and reduce the length of the muscles of the upper trapezius, scapulae, and pectoralis major and its fibers. The present study improved the posture of the head and neck by strengthening mentioned muscles through corrective exercises. In the forward head posture, the head is in front of the center of gravity, putting much pressure on the neck joints and muscles behind the neck [45]. In neck pain, the deep flexors of the neck (Longus Capitis, Longus Colli, and Rectus Capitis Anterior) lose their strength and endurance, and their activity decreases, the superficial muscles (sternocleidomastoid and anterior scalene) [46] get tired sooner, and their neuromuscular function decreases. A simple exercise routine can effectively prevent such problems [47].

A comparison of the mean angles and the forward head position showed that typing posture was more undesirable than reading. The mean angle of the head tilt, the gaze angle, and the forward head position increased, and the neck tilt decreased, setting the head and neck in an inappropriate position. Corrective movement exercises by strengthening the upper trapezius muscle and improving local blood circulation [48] could help improve angles and head and neck position, thus reducing pain.

One of the limitations of the present study is the unwillingness to cooperate and participate in completing the questionnaires and performing the corrective exercises. This can be eliminated by increasing people's awareness of the importance of this issue and encouraging them to participate. Given the workstation in the individual posture, in future studies, the survey of workstations is also suggested. In addition, since time is an essential factor in assessing the employee's posture, the role of the work duration and its effect on neck pain should be examined. It is also possible to obtain more accurate information about the individual's head and neck position by performing electromyography at the beginning and end of the intervention. The strengths of our study are considering the real workstation and measuring angles in repetitive postures. Weaknesses or limitations not considered in our research are cited as suggestions for future studies.

Conclusion

The study findings show that nurses are at risk for various levels of occupational stress. This emphasizes developing programs to reduce the stress on nurses. On the other hand, nurses need creativity to fulfill patients' complex needs, but occupational stress decreases creativity. Officials must consider creativity as an inseparable part of clinical strategies and build a stress-free environment where nurses can follow their creative measures. They also should recognize the risk factors of occupational stress and prepare targeted interventions to lower it, thus helping creativity emerge.

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