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Original

Ergonomic Analysis of the Neck Posture in Computer Users and Identifying the Related Risk Factors

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Abstract

Background: Neck disorder is a common complaint in computer users which affects the task performance and fatigue. Several studies confirmed the relation between neck discomfort and working with a computer. But focusing on the root risk factors inducing neck discomfort can be applied for taking preventive measures and improving workstation design. So, the main purpose of this study was the neck posture analysis in computer users and identifying the related risk factors. **Methods:** This descriptive-analytical study was performed in 2018 on 169 administrative staff in one of the governmental hospitals in Qom. A researcher-made questionnaire was used to investigate neck discomfort and related risk factors. To determine the angle of the neck, photographic analysis method was used. Finally, SPSS software version 22 and appropriate statistical tests including the logistic regression model, two independent t-test, and chi-square test in contingency tables were used to determine the relationship between individual parameters and workstation with neck angles and neck pain. **Results:** The results showed that two factors of the height (p= 0.023) and the gender (p= 0.012) had a direct statistically significant association with neck disorder statistically. In addition, the anthropometric dimensions, monitor height from desk level was positively correlated with neck discomfort but sitting elbow to eye height was negatively correlated with neck discomfort (p<0.05). Odds Ratio analysis showed that moderate and severe monitor angle compared to neutral posture (monitor angle less than 10 °) can increase neck discomfort as 1.925 and 3.137, respectively. **Conclusion:** Generally, it can be concluded that workstation design can affect taking a posture in computer users. So, establishing correct workstation criteria such as eye height, monitor height from desk level and sitting elbow to eye height dimensions are very important. However, determination of the proportion of each parameter effect is strongly recommended for other investigations. This can develop preventive measures for reducing neck awkward postures.

Keywords: Neck; Posture; Disorder; Workstation; Design

Introduction

Musculoskeletal disorder is one of the most important causes of occupational injury and disability in many working environments in developed and developing countries, causing huge economic costs to industries in these countries. At present, control and reduction of musculoskeletal disorders among the workforce

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are one of the most important problems of ergonomic specialists around the world. One of the devices that can be seen in all work environment, especially in office environment, is the computer, whose usage has increased dramatically over the past 20 years. According to statistics released in 2000, 60% of the workforce needed computer tasks for part of their jobs, and 80% of the workforce reported using a computer on a daily basis.[1]Among the jobs that are exposed to work-related musculoskeletal disorders, due to their nature, are computer users. Expanding the use of computers in different work environments, especially administrative environments, highlights the importance of conducting scientific research in this area. According to some researchers, the prevalence of musculoskeletal disorders in computer users is higher than other workers.[2-3]

On the other hand, the increasing spread of new technologies and knowledge has led to an increase in the speed of work and an increase in production and productivity but has had consequences such as inactivity, fatigue, neuropsychological stress, and an increase in the incidence of musculoskeletal disorders. Researches have shown that pain and discomfort in various parts of the musculoskeletal system are major problems in working environment and are the main cause of absenteeism. Studies have shown that more than half of the absences in the workplace are musculoskeletal disorders. Hence, in many countries the prevention of WMSDs has become a necessity and national priority.[4-6] More than 76% of the administrative staff in developing countries complain of physical discomfort, many of which are associated with musculoskeletal disorders. The prevalence of musculoskeletal disorders among developing countries has been reported between 14% and 66% depending on the type of work with the computer and the duration of the contact with the computer.[7-12]

Working with a computer can cause musculoskeletal disorders in various parts of the body, including the neck, shoulder, elbow, wrists, and fingers. In a study in the United States, the prevalence of musculoskeletal disorders in computer users is estimated at 54%, the most common being in women in the neck and shoulders. The failure of users to observe the correct posture will have irreparable effects on their health. Performing repetitive movements, limiting, focusing on the screen and using the keyboard has made people exposed to static pressure on their bodies. As time passes and as the work progresses, musculoskeletal injuries in the neck, shoulder, arm, wrists, waist, and knee will increase.[13] Among the most important factors affecting the formation of body posture in computer users is the shape and location of the screen, mouse, chair, and keyboard. Musculoskeletal disorders, commonly in the upper limb, wrist, head, neck, and lower back, are common among computer users.[14-16]

Moreover, the use of laptops alongside desktop computers that has seen significant increases in recent years is another reason for the development of musculoskeletal disorders in these individuals. The main reasons for using this device are the intrinsic characteristics of the laptop, such as portability, lightness, proper size, and the easy use at anytime from anywhere. But on the other hand, these features have made usersnot to be able to maintain their normal state of the body and take undesirable poses.[17] From an ergonomic point of view, the design of the laptop is not based on the ergonomic principles of a computer, since the keyboard and the monitor plate are linked together, and when used, the amount of bending of the neck, the amount of torque applied, tissue stress and physical discomfort increases. In addition, further forward deviations, reduced head movements, and less distance from the monitor screen lead to eye and musculoskeletal discomfort in working with a laptop compared to working with a computer. Therefore, workstation should have the ability to adjust the height of the keyboard and monitor the distance to suit the appropriate work.[18]

Generally, probable risk factors may include individual risk factors such as sex, age, BMI, etc., physical factors such as long hours of work daily, working with the mouse and keyboard, static condition of the head and neck during work, working with elevated shoulders, high workload, poor workstation design, and psychological and social factors associated with work, including the possibility of decision-making in work, time pressure, the status of support for managers and associates, work satisfaction and control in work.[18] Complications of the neck and shoulders can be accompanied by severe symptoms such as pain, numbness, and tingling, which reduces the productivity and disability of the task and increases the cost of compensation for work. Among the stated risk factors, the awkward posture is is one of the main causes of these problems in office jobs caused by improper design of the workstation, and the use of non-ergonomic and fixed chairs and tables over time.[19] Today, in many countries, the prevention of musculoskeletal disorders related to office work has become a necessity and a national

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priority. Many studies have been conducted on the prevalence of musculoskeletal disorders among computer users around the world, including Iran. But as the results of most of these studies have indicated a greater prevalence of disturbances in neck areas,[18, 20-21] this study was designed and implemented to identify the risk factors for the development of neck pain in a more specific group of computer users.

Methods

This descriptive-analytical study was performed in 2018 on 169 administrative staff in one of the governmental hospitals in Qom. Sample subjects were randomly selected from people with the work experience of at least one year who used computer at least 4 hours a day at their workplace and entered the study after justifying the goals of the study and taking oral satisfaction. The history of musculoskeletal disorders that were unrelated to labor, pregnant women and subjects with second job were considered as the exclusion criteria. A researcher-made questionnaire was used to collect demographic data and information on discomforts in the neck area. Content validity of the researcher-made questionnaire was done through a panel of experts (ten people) and content test and the calculation of validity ratio and validity index of the questionnaire (CVR=0.76, CVI= 0.73). The reliability of this questionnaire was also achieved by conducting a pilot study on 20 populations under study and performing test (r = 0.78) and Cronbach's alpha test (r = 0.91).

All the required information was collected according to the goals of the study by this questionnaire. In general, a part of the questionnaire contained questions about the dimensions of the monitor, the status of the workstation and the posture of individuals. The other part of the questionnaire was a pain score in the neck area to determine the intensity of pain and time pattern, which was used for this purpose with a 5-degree Likert scale. Then, to determine the angle of the neck, while the subjects were busy with their actual work, their neck angle was recorded relative to the perpendicular surface based on the patterns and using the photographic method. The photos were captured by Canon's Lexus 175 camera. For this purpose, in each evaluation, the researcher was trained for 20 minutes on how to position the neck of the person during the work, and was photographed from the neck and spine at a time interval of 30 seconds. A total of 40 images were provided for each person. After the photos were taken, they were transferred to the computer and the most common posture of the individual at work was selected to determine the angle needed and the next analysis in this study.

As mentioned, selected anthropometric dimensions of the subjects and the dimensions of the workstation, including eye height in sitting position, popliteal height (height below the knee to the floor), the height of the elbow in sitting position, the angle of the monitor with the hypothetical vertical line, etc. as well as the prevalence of disturbances in the neck region were gathered using a questionnaire. The angle of the monitor with the hypothetical vertical line was classified to three categories including neutral angle (monitor angle less than 10 °), moderate angle (monitor angle between 10° up to 20 °) and severe angle (more than 20 ° forward or backward angle). The mean± Standard deviation (SD) as well as frequency, n (%), were used to describe the variables. The ordinal logistic regression was used to test the association between neck pain and workstation parameters. The independent T-test and Chi-Square test in contingency tables were used to compare the characteristics of healthy individuals and the ones with neck pain. The statistical analysis was conducted using SPSS software version.[22]

Results

The mean and standard deviation of the age of subjects were 36.42 (4.18) years. 45.5% of the subjects were male and 54.5% of the participants were women. 97.1% of the people in the workplace used desktop computers and 2.9% used laptops. Furthermore, with regard to the design limitations of the workstation, 61.8% of the people did not have the opportunity to redesign their workstation due to space constraints, and only 38.2% of the individualscould redesign their workstation. The results of the assessment of the feeling of discomfort in the neck area showed that 34.7% of the participants experienced a feeling of discomfort in the neck region with different intensities and frequencies, and the remaining 65.3% had no discomfort.

The relationship between the demographic variables of the study and the prevalence of neck disorders among the computer users showed that two factors of the height (p = 0.023) and the gender (p = 0.012) had a statistically significant association with the neck disorder. So that, in men, the proportion of people with disturbances in the neck region compared to non-disrupted individuals was 0.61 and in women the ratio was 1.43 figure 1. In other words,

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according to the results of the present study, the use of computer in women was more likely to cause disturbances in the neck region than men ($p<0.05$). The anthropometric information of the subjects studied is presented in Table 1. The results showed that among studied anthropometric dimensions, height, monitor height from desk level and sitting elbow to eye height had a significant relationship with neck discomfort ($p<0.05$).

The prevalence and severity of the discomfort felt in the neck area of these individuals are shown in Table 2. In addition, the information about the angle of the monitor and the status of the neck are shown in Table 3.

Figure 2 shows the relationship between the incidence of neck pain and the angle of the monitor, and Figure 3 shows the relationship between the incidence of neck pain and the restriction of work station settings among computer users.

Table 1. The characteristics and anthropometric measurements between healthy participants and the participant with neck pain (n=169)

Group Statistics					
Parameter	Neck discomfort	Mean	Std. Deviation	Std. Error Mean	*P*-value*
Height	Yes	165.54	8.63	1.12	0.023
	No	168.99	9.49	0.91	
Weight	Yes	73.00	13.20	1.72	0.736
	No	73.01	17.85	1.70	
Sitting eye height	Yes	70.61	4.27	0.56	0.132
	No	71.65	4.72	0.45	
Monitor height from desk level	Yes	44.88	7.26	0.95	0.046
	No	43.56	8.53	0.81	
Eye horizontal distance to the system	Yes	77.44	13.80	1.80	0.668
	No	75.50	10.70	1.02	
Sitting elbow height	Yes	20.88	2.51	0.33	0.290
	No	21.26	2.37	0.23	
Sitting elbow to eye height	Yes	49.46	3.93	0.51	0.006
	No	51.21	4.15	0.40	
Popliteal height	Yes	48.50	3.54	2.50	0.650
	No	46.33	4.46	1.82	

*$P<0.05$

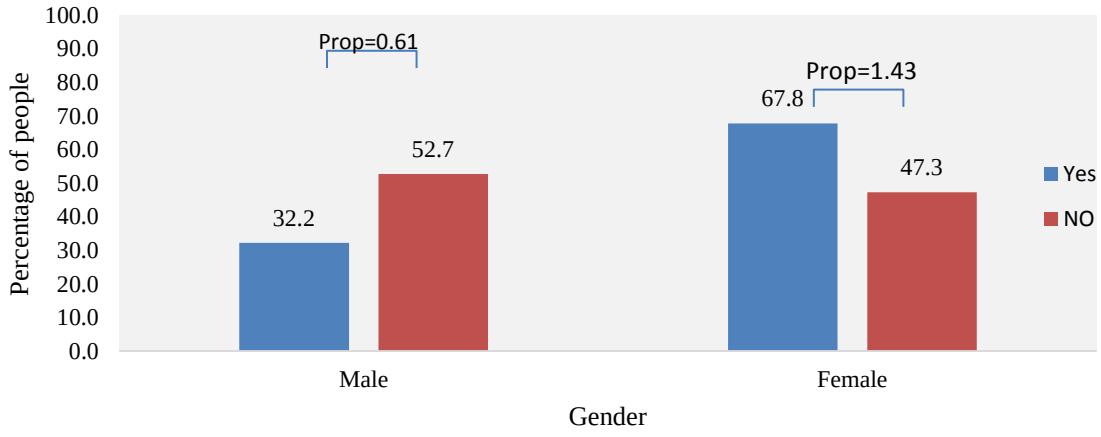

Figure 1. The relation of discomfort sensation in the neck region and the gender (Prop: Disruption ratio in male and female with and without neck discomfort)

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Table 2. Prevalence and intensity of neck discomfort among the studied subjects (n=169)

Discomfort prevalence; n (%)					Discomfort intensity; n (%)				
At all	Rarely	Occasionally	sometimes	Always	Nothing	Slight	Mild	Moderate	Severe
110 (65.3)	1 (0.6)	30 (17.6)	10 (5.9)	18 (10.6)	110 (65.3)	2 (1.2)	8 (4.7)	16 (9.4)	33 (19.4)

Table 3. Descriptive statistics of monitor angle and neck position of subjects

Monitor angle; n(%)			Neck angle; n(%)				Neck rotation; n(%)	
Neutral	Moderate	Severe	<10	10-20	>20	Negative angle	Yes	No
107 (62.9)	42 (24.9)	20 (12.2)	28 (16.5)	107 (62.9)	33 (19.4)	1 (0.6)	40 (23.5)	129 (76.5)

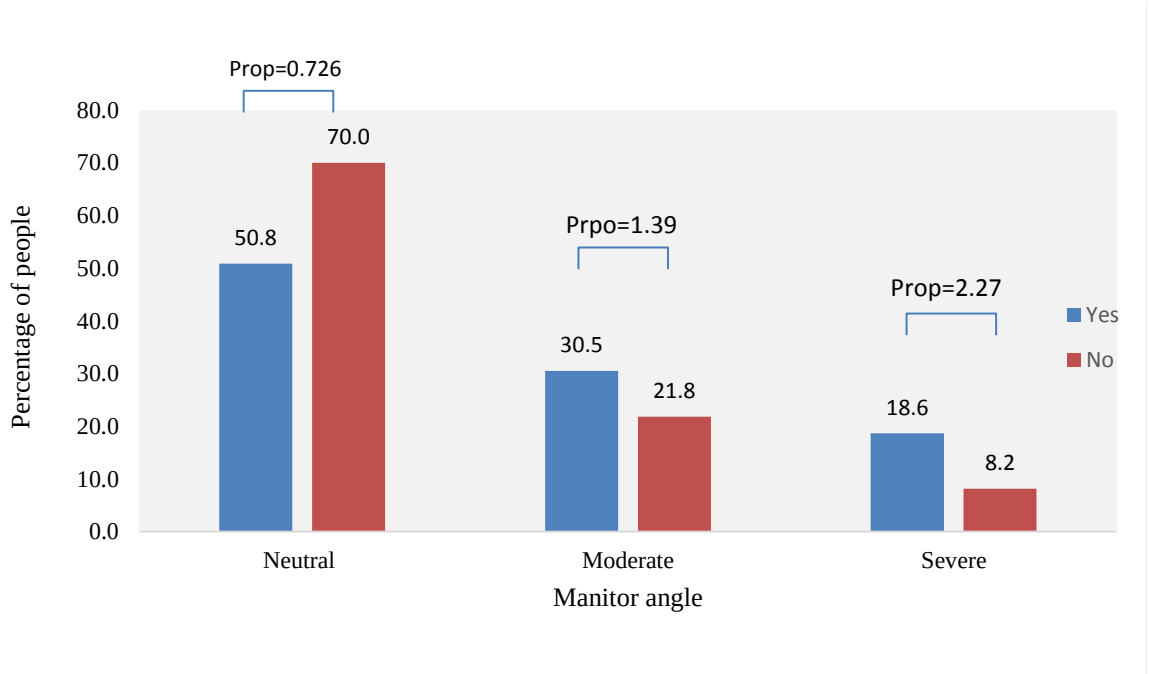

Figure 2. The relation of discomfort sensation in the neck region and the angle of the monitor (Prop: Disruption ratio in people with and without (neutral angle) monitor angle)

Table 4. The ordinal logistic regression results of the association between different monitor angle and neck discomfort.

	B	S.E.	Wald	P-value*	Odds Ratio	95% C.I.for OR	
						Lower	Upper
Neutral (Reference group)	-	-	-	-	-	-	-
Moderate Monitor Angle	0.655	0.379	2.988	0.084	1.925	0.916	4.045
Severe Monitor Angle**	1.143	0.498	5.263	0.022	3.137	1.181	8.331

*P< 0.05

** variable with direct significant relation

Based on the results of Table 4, moderate and severe monitor angle compared to neutral posture (monitor angle less than 10 °) can increase neck discomfort as 1.925 and 3.137, respectively (Odds Ratio value). Although, only severe monitor angle (more than 20 ° forward or backward angle) showed significant relation with regard to neutral angle (p=0.022).

The results of figure 3 shows that the subject's with workstation adjustment limits have experienced more neck discomfort than the subjects who could redesign their workstationc(1.19 versus 0.72). In other words, workstation redesign can prevent neck disorders among computer users.

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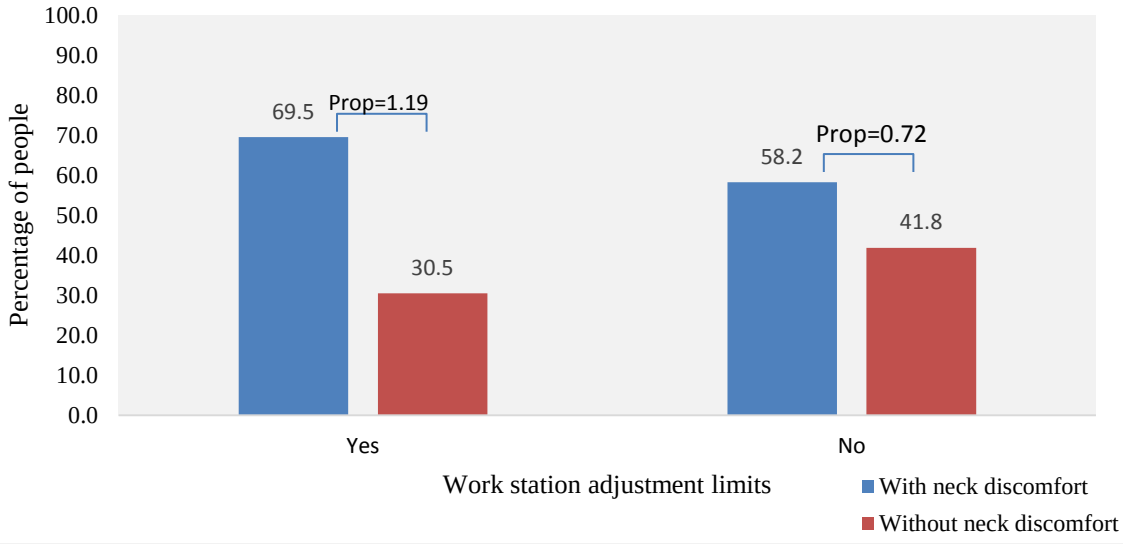

Figure 3. The relation of discomfort sensation in the neck region and ability of work station redesign (Prop: Disruption ratio in people with and without workstation adjustment limits)

Discussion

The main objective of this study was to determine risk factors which correspond to making neck posture and related neck discomfort among computer users. This work was done among personnel in a governmental hospital. The results showed that the relationship between the demographic variables of the study and the prevalence of neck disorders among the computer users were statistically significant for the height (p = 0.023) and the gender (p = 0.012). It can be cocluded that, as shown in figure 1, the proportion of people with disorders in the neck region compared to non-disrupted individuals was more in the women compared to the men (1.43 versus 0.61). In other words, the use of computer in women was more likely to cause disturbances in the neck region than men (p<0.05). In the line of the present study, Choobineh et al. found that among the bank employees' disorders of shoulder is higher in women than men.[22] On the other hand, among studied anthropometric dimensions, height, monitor height from desk level and sitting elbow to eye height had a significant relationship with neck discomfort (p<0.05).

Habibi et al., showed that educational intervention regarding the ergonomic design of work station can improve work station criteria and reduce neck pain among computer users, significantly.[23] So, it can be concluded that the improvement work station risk factors identified in present study can diminish neck disorders, similarly. The results of the assessment showed that most of the participants had moderate (62.9%) and severe (19.4%) neck angle during working with the visual display terminal (VDT). The neck angle can be a probable risk factor for neck and shoulder disorders. A study revealed that elbow support can be suggested as a mechanism to delay trapezius muscle fatigue and reducing of neck and shoulder discomfort.[24]

Many parameters can cause neck angles such as inappropriate height of monitor related to eye height, horizontal distance of monitor to eye, poor condition of environment such as inadequate lighting, eye weakness or using bifocal glasses, chair adjustment restraint and so on.[25-28] For example, in our research, the subjects with work station adjustment limits have experienced more neck discomfort than subjects without ones (1.19 versus 0.72). In other words, work station redesign can prevent neck disorders among computer users. These findings can be seen in other studies.[23, 29-31] Based on the gained results, a severe monitor angle (more than 20° forward or backward angle) shows significant relation compared to neutral angle (p=0.022). the main reason for neck awkward postures is probably sitting height. So that, inappropriate sitting height can result improper eye height regarding the monitor height. This can be seen both in the findings of this study and also other studeis.[32]

Conclusion

Generally, it can be concluded that workstation design can have an effect ontaking a posture in computer users. So, establishing correct workstation criteria such as eye height,

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monitor height from desk level and sitting elbow to eye height dimensions are very important. However, determination of proportion of each parameter effect is strongly recommended for other investigations. This can develop preventive measures for reducing neck awkward postures.

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