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Evaluation of Musculoskeletal Disorders and Ergonomic Risk Factors Among Office Workers of Kashan University of Medical Sciences in Iran

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Abstract

Background: Ergonomic risk factors are among the critical risk factors for musculoskeletal disorders (MSDs) in office workers.
Objectives: This study investigated the MSD prevalence and the ergonomic risk factors of staff workstations at Kashan University of Medical Sciences (KAUMS), Kashan, Iran.
Methods: This cross-sectional study was conducted in 2021. The samples were the office workers of KAUMS who had more than one year of work experience and worked with computers for at least 3 hours a day on average. The samples were selected using the stratified sampling method, and finally, 132 employees participated in the study. The data were collected using the Cornell Musculoskeletal Discomfort Questionnaire and the rapid office strain assessment (ROSA) checklist. The data were analyzed using Wilcoxon, Mann-Whitney U, Kruskal-Wallis, Spearman's correlation, and non-parametric regression tests by SPSS software (version 26).
Results: The mean age of the participants was 40.16 ± 7.79 years, and 62.9% of the subjects were female. Female subjects complained significantly more about MSDs than male subjects ($P < 0.05$). The most widely recognized MSDs were neck, lower back, and upper back pain. Disorders in the right-sided upper limb were essentially more frequent than in the left ($P < 0.05$). All chairs, 62.1% of the monitors-telephones, and 90.9% of the mouses-keyboards in workstations were in a warning or dangerous condition. The scores of MSDs in the vertebral column, shoulder girdle, forearm, lower back, and lower limbs were fundamentally related to the ROSA score in the monitor section.
Conclusions: The most widely recognized MSDs among office workers were neck, lower back, and upper back pain, respectively. Female employees had more MSDs. All workstations (100%) were in an unsafe position, and the MSDs of the vertebral column, shoulder girdle, forearm, lower back, and lower organ were related to the position of the monitors. Accordingly, corrective interventions, particularly the adjustment of monitor placement in office workstations, are fundamental.

Keywords: Ergonomics, Musculoskeletal Disorders, Prevalence, Computers

1. Background

Musculoskeletal disorders (MSDs) address almost half of occupational illnesses and causes of absenteeism (1). The MSDs are brought about by a wide range of inappropriate conditions affecting muscles, tendons, ligaments, joints, peripheral nerves, and blood vessels and cause symptoms such as discomfort, pain, burning, tenderness, inflammation, limited range of motion, and sensational abnormalities (2). The prevalence of MSDs in computer users, including office workers, is high and has individual and occupational risk factors (3). Occupational risk factors include prolonged and sedentary office work hours, high workload or demand, inappropriate workstation design, inappropriate postures, contact stresses, performing repetitive tasks, and use of non-ergonomic office equipment (1, 3-6). Ergonomic risk factors during work have cumulative effects and gradually cause MSDs over time. Therefore, the identification and evaluation of risk factors and their control in the work environment and corrective measures are necessary to ensure the workforce's health (5).

The awareness of the most common MSDs, the relationship between the ergonomic risk factors of different parts of the workstation (e.g., chair, monitor, telephone, and desk), and the type of employees' daily tasks with their MSDs can guide the management system to adopt the necessary solutions (e.g., teaching therapeutic exercises related to that specific organ, providing standard office equipment, and changing the workstation arrangement) (6-8).

In the conducted studies, various areas, such as the neck, lower back, or shoulder, have been mentioned as the most common MSDs in computer users (1, 6, 9-12). The relationship between the ergonomic hazards of different parts of the desk with the MSDs of computer users is not clear. In some studies, there was a significant relationship between MSDs and ergonomic risk factors, for example, upper back pain with the back condition of the chair, hips, and thighs pain with the space under the table, neck pain with the height of the monitor, shoulder pain with hand posture in typing position, and hands pain with the place of the mouse and keyboard (13). There was no relationship between these items in other studies (14). There are few studies regarding the relationship between the workplace and the daily tasks of employees with MSDs (8, 15).

2. Objectives

This study was designed to determine the most common organs involved in MSDs among office workers and whether these complaints are related to the ergonomic risk factors of workstations and workplaces at Kashan University of Medical Sciences (KAUMS), Kashan, Iran, in 2021.

3. Methods

This cross-sectional analytical study was conducted in 2021. The study population included the office workers of KAUMS. A total of 158 employees were selected from all the employees (n = 268) using Morgan's table (or Cochran's formula). The samples were selected using the stratified sampling method (the classes, including the faculties (medicine, dentistry, para medicine, health, and nursing-midwifery) and vice-chancellors (student-cultural, research-technological, and educational)) and the online website for generating random numbers (www.stattrek.com), and the employees were divided into administrative/educational and headquarters/management employees, respectively.

After explaining the research objectives to the employees and obtaining written consent to participate in the study, the Cornell Musculoskeletal Discomfort Questionnaire, along with demographic questions (i.e., information about age, gender, marital status, education status, workplace, type of employment, recruitment time, average daily hours of computer work, history of trauma, and any known neurological or orthopedic diseases), was provided to the subjects for completion.

The office workers who had more than one year of work experience and worked with computers for at least 3 hours a day on average (12-14, 16) were enrolled in the study. Individuals with a history of major musculoskeletal trauma and neurological or orthopedic diseases were not included in the study. Individuals who incompletely filled out the questionnaires were excluded from the study. Then, while the participating employee was working (at the computer workstation), the researcher observed his/her body posture and work environment and scored using the rapid office strain assessment (ROSA) checklist. Completing the ROSA checklist was performed by a trained occupational health expert under the supervision of a physical medicine and rehabilitation specialist. To avoid the healthy worker bias regarding the follow-up of absent, on leave, and sick cases, evaluations were carried out on the first three days of the week, in the first 4 hours of the work shift, and only at the first visit to the person.

The Cornell questionnaire is a self-report form developed by Allen Hedge in 1999, and the validity and reliability of its Persian version were confirmed (kappa = 0.82 - 0.96, the Spearman correlation coefficient = 0.836 - 0.941, and the Cronbach's alpha = 0.986) (1). Pain or discomfort in every 12 parts of the body is assessed by multiplying the score of three parts (i.e., discomfort frequency, discomfort severity, and impact of this discomfort on workability). Then, the Cornell score is obtained from the sum of the discomfort scores of all 12 organs (17-19).

The ROSA method is a high-speed pen-and-paper method based on the EN-ISO 9241, 1997 standard, and evaluates the number of ergonomic risk factors at computer workstations. The face and convergent validity of the Persian version of ROSA have been confirmed by Armal et al. (20). In this method, different workstation parts, including the chair, monitor and phone, mouse, and keyboard, are scored (21). The possible total score of this checklist is 0 - 10, which is interpreted as low risk or safe zone with no need for intervention (scores less than 3), moderate risk (scores 3 - 5), and high risk or danger zone with the need for immediate intervention (scores 6 - 10) (1).

3.1. Statistical Analysis

The data were analyzed through SPSS software (version 26) and using descriptive statistics (i.e., frequency distribution and central and dispersion indices) and inferential statistics (i.e., the Wilcoxon test to compare discomfort score between right and left organs, Mann-Whitney U test to compare Cornell score according to two-mode qualitative variables, Kruskal-Wallis test to compare Cornell score according to multi-mode qualitative variables, Spearman's correlation test to check the correlation of Cornell score with quantitative variables, and non-parametric regression test to check the multiple correlations of Cornell score with independent variables).

3.2. Ethical Considerations

This study was a medical student's thesis and was approved by the Research Ethics Committee of KAUMS (code: IR.KAUMS.MEDNT.REC.1400.090). The samples were ensured of confidential data management and access to the study findings. Written informed consent was obtained from the study subjects.

4. Results

Of the 132 participating employees (response rate = 83% (132/158)), approximately 63% were female, and the mean age was 40.16 ± 7.79 years (Table 1). The findings in Table 2 show that the discomfort score (based on the Cornell questionnaire) in the neck (13.32), lower back (13.28), and upper back (12.22) was higher than in other parts. Additionally, the discomfort score on the right-sided shoulder, arm, forearm, wrist, and whole upper limb was significantly higher than the left-sided ones.

According to ROSA's score, most employees (62.9%) were in the danger zone, and none of them was in the safe zone (Table 3). The findings of Table 4 show that only gender had a significant relationship with the Cornell score (P = 0.025); accordingly, the Cornell score (mean rank) was higher in females (72.05) than in males (57.10). In addition, among ROSA items, only the monitor/telephone score had a significant positive relationship with some organ discomfort scores (i.e., neck, upper back, forearm, buttocks, thigh, leg, and ankle), which are mentioned in Table 5.

Table 1. Demographic Characteristics of Employees

Variables	No. (%)	Mean ± SD	Min - Max
Gender			
Male	49 (37.1)		
Female	83 (62.9)		
Age (y)		40.23 ± 7.72	25 - 58
< 35	34 (25.8)		
35 - 40	37 (28)		
> 40	61 (46.2)		
Body mass index (kg/m^2)		26.04 ± 4.00	13.22 - 37.02
< 18.5 (thin)	5 (3.8)		
18.5 - 24.9 (normal)	45 (34.1)		
25 - 29.9 (overweight)	61 (46.2)		
≥ 30 (obese)	21 (15.9)		
Marital status			
Single	23 (17.4)		
Married	109 (82.6)		
Educational level			
Diploma/associate	15 (11.4)		
Bachelor's and higher	117 (88.6)		
Workplace unit			
Headquarters/managemen	64 (48.5)		
Administrative/educational	68 (51.5)		
Work experience (y)		14.11 ± 8.60	1 - 33
< 10	42 (31.8)		
10 - 15	39 (29.5)		
16 - 20	22 (16.7)		
> 20	29 (22)		

5. Discussion

In this study, the greatest pain and discomfort of the staff was in the neck area, followed by the lower back, which is in line with the results of most similar studies in this regard (1, 22, 23). The common causes of neck pain and discomfort in computer users and office workers were the anatomical structure of the neck (i.e., the most moving part of the spine and the possibility of changing its direction in different axes and bearing the weight of the skull when working with computers), improper positions, such as forward head posture and static posture, and inappropriate design of workstations (24, 25). In some studies, the most common site of MSDs has been reported differently; for example, Cho et al. (26) regarded the shoulder and Riyahi et al. (6), Jafari Nodoushan et al. (10), and Choobineh et al. (5) the lower back as the most common part.

Several factors contribute to the differences in study results in determining the most common organ involved in MSDs. The condition of workstation equipment, job types, and the details of daily tasks of individuals might be effective in different results. Moreover, the number of working hours per day with the computer is important; therefore, more than 2 to 3 hours a day is a threshold for neck pain and more than 5 hours for lower back pain (27). In the present study and other mentioned studies, the details of the work tasks and the number of work

Table 2. Frequency Distribution of Employees' Responses to Musculoskeletal Status Based on Cornell Questionnaire

Organ	Frequency					Discomfort			Interference			(Mean) Discomfort Score
	Never	1 - 2 Times/Week	3 - 4 Times/Week	Once Every Day	Several Times Every Day	Slightly Uncomfortable	Moderately Uncomfortable	Very Uncomfortable	Not at All	Slightly Interfered	Substantially Interfered	
Neck	47 (35.6)	36 (27.3)	18 (13.6)	12 (9.1)	19 (14.4)	20 (23.5)	53 (62.4)	12 (14.1)	17 (20)	46 (54.1)	22 (25.9)	13.32
Shoulder [a]												
Right	76 (57.6)	23 (17.4)	13 (9.8)	6 (4.5)	14 (10.6)	18 (32.1)	27 (48.2)	11 (19.6)	13 (9.8)	30 (53.6)	13 (23.2)	8.79
Left	87 (65.9)	21 (15.9)	11 (8.3)	3 (2.3)	10 (7.6)	17 (37.8)	19 (42.2)	9 (20)	14 (31.1)	23 (51.1)	8 (17.8)	6.23
Upper back	61 (46.2)	24 (18.2)	17 (12.9)	10 (7.6)	20 (15.2)	27 (38)	29 (40.8)	15 (21.1)	23 (32.4)	32 (45.1)	16 (22.5)	12.22
Arm [a]												
Right	98 (74.2)	18 (13.6)	5 (3.8)	4 (3)	7 (5.3)	13 (38.2)	20 (58.8)	1 (2.9)	13 (38.2)	16 (47.1)	5 (14.7)	3.89
Left	108 (81.8)	10 (7.6)	7 (5.3)	3 (3.2)	4 (3)	13 (54.2)	10 (41.7)	1 (4.2)	11 (45.8)	12 (50)	1 (4.2)	1.70
Lower back	53 (40.2)	30 (22.7)	18 (13.6)	6 (4.5)	25 (18.9)	33 (41.8)	33 (41.8)	13 (16.5)	26 (32.9)	38 (48.1)	15 (19)	13.28
Forearm [a]												
Right	105 (79.5)	17 (12.9)	4 (3)	1 (0.8)	5 (3.8)	17 (63)	6 (22.2)	4 (14.8)	11 (40.7)	13 (48.1)	3 (11.1)	2.70
Left	111 (84.1)	13 (9.8)	4 (3)	1 (0.8)	3 (2.3)	13 (61.9)	5 (23.8)	3 (14.3)	12 (57.1)	7 (33.3)	2 (9.5)	1.68
Wrist [a]												
Right	88 (66.7)	19 (14.4)	9 (6.8)	4 (3)	12 (9.1)	16 (36.4)	22 (50)	6 (13.6)	13 (29.5)	23 (52.3)	8 (18.2)	5.98
Left	103 (78)	15 (11.4)	5 (3.8)	1 (0.8)	8 (6.1)	11 (37.9)	14 (48.3)	4 (13.8)	9 (31)	16 (55.2)	4 (13.8)	3.64
Buttocks	94 (71.2)	17 (12.9)	8 (6.1)	2 (1.5)	11 (8.3)	18 (47.4)	13 (34.2)	7 (18.4)	10 (26.3)	18 (47.4)	10 (26.3)	6.77
Thigh												
Right	100 (75.8)	16 (12.1)	7 (5.3)	4 (3)	5 (3.8)	16 (50)	13 (40.6)	3 (9.4)	14 (43.8)	14 (43.8)	4 (12.4)	3.86
Left	100 (75.8)	17 (12.9)	4 (3)	5 (3.8)	6 (4.5)	16 (50)	11 (34.4)	5 (15.6)	12 (37.4)	14 (43.8)	6 (18.8)	4.25
Knee												
Right	79 (59.8)	25 (18.9)	9 (6.8)	5 (3.8)	14 (10.6)	26 (49.1)	21 (39.6)	6 (11.3)	20 (37.7)	26 (49.1)	7 (13.2)	6.67
Left	85 (64.4)	18 (13.6)	10 (7.6)	5 (3.8)	14 (10.6)	21 (44.7)	19 (40.4)	7 (14.9)	16 (34.1)	23 (48.9)	8 (17)	6.77
Leg												
Right	94 (71.2)	21 (15.9)	8 (6.1)	2 (1.5)	7 (5.3)	18 (47.4)	13 (34.2)	7 (18.4)	14 (36.8)	17 (44.7)	7 (18.4)	5.30
Left	96 (72.7)	21 (15.9)	7 (5.3)	1 (0.8)	7 (5.3)	17 (47.2)	13 (36.1)	6 (16.7)	12 (33.3)	18 (50)	6 (16.7)	4.59
Ankle												
Right	94 (71.2)	18 (13.6)	7 (5.3)	2 (1.5)	11 (8.3)	16 (42.1)	14 (36.8)	8 (21.1)	12 (31.6)	19 (50)	7 (18.4)	7.00
Left	94 (71.2)	22 (16.7)	8 (6.1)	0	8 (6.1)	17 (44.7)	14 (36.8)	7 (18.4)	12 (31.6)	20 (52.6)	6 (15.8)	5.51

[a] Significant difference in discomfort score between the right and left (Wilcoxon test).

hours with the computer have not been reported. In addition, the use of different MSD evaluation tools (e.g., the Nordic questionnaire and Cornell questionnaire) can also contribute to the differences in the results (9). The Cornell tool was used in the present study and Mianehsaz et al.'s study (1). However, Salehi Sahlabadi et al. (11), Ghanbary-Sartang and Habibi (12), and Choobineh et al. (5) used the Nordic questionnaire, and Riyahi et al. (6) used Nordic questionnaires and body map.

It seems that the different understanding of the words "shoulder", "upper back", and "lower back" by the samples in different studies can also play a role in the differences in the results. Therefore, it is necessary for the researchers to clearly explain the mentioned areas for the samples performed in the present study. In studies where questionnaires were sent to individuals by mail or e-mail (26-28), the explanation of these anatomical terms and the justification of the participants were questionable. The way to analyze the MSD score in the organs separately from the right and left or the sum of the organs on both sides has an impact on the final results. In this study, the MSDs of the right and left organs were reported and analyzed independently. Nevertheless, in some studies, the results of the right and left organs were reported aggregately (5,

Table 3. Ergonomic Evaluation of Employees Using Rapid Office Strain Assessment Method

ROSA	No. (%)	Mean ± SD	Min - Max
Chair			
Seat pan height		2.25 ± 1.30	1 - 6
Seat pan depth		2.26 ± 0.69	1 - 3
Armrests		2.89 ± 0.89	1 - 5
Back support		2.83 ± 0.84	1 - 5
Total		6.12 ± 1.74	3 - 10
Safe	0		
Warning	51 (38.6)		
Danger	81 (61.4)		
Monitor and telephone			
Monitor		3.51 ± 1.24	0 - 6
Telephone		1.60 ± 1.02	0 - 6
Total		3.04 ± 1.18	1 - 7
Safe	50 (37.9)		
Warning	77 (58.3)		
Danger	3 (3.8)		
Mouse and keyboard			
Mouse		2.48 ± 1.05	0 - 6
Keyboard		3.36 ± 0.69	2 - 5
Total		3.77 ± 1.15	1 - 7
Safe	12 (9.1)		
Warning	116 (87.9)		
Danger	4 (3)		
Total score		6.20 ± 1.68	3 - 10
Safe	0		
Warning	49 (37.1)		
Danger	83 (62.9)		

Abbreviation: ROSA, rapid office strain assessment.

11, 29).

In this study, MSDs were more frequent in the right upper organs than in the left. The predominance of the right hand and its use while working with the mouse and keyboard can justify this finding. There is no information about this finding in other studies (6, 30). In this study, the rate of MSDs among female employees was significantly higher than in male employees, which is similar to the results of Cho et al. (26), Riyahi et al. (6), Gorgi et al. (29), and Mianehsaz et al.'s studies (1). Childcare, women's small size, smaller muscle volume than men, and not paying attention to their anthropometric characteristics when buying office equipment have caused the female gender to be considered a risk factor for MSDs (27, 31). In Nadri et al.'s study, MSDs were more frequent in male than female employees (23), and in Akbari et al.'s study, there was no significant relationship between gender and MSDs (14). The difference between the results of the previous study and the two mentioned studies could be due to the frequency distribution of both genders in these studies; accordingly, in the present study, 63% of the employees were female; however, in the two mentioned studies, 13% and 23% of the samples were female, respectively.

In this study, there was no significant relationship between age and work experience of employees (40.23 ± 7.72 and 14.11 ± 8.60 years, respectively) with MSDs. This finding is similar to the results of studies by Griffiths et al. (28), Tinubu et al. (32), Riyahi et al. (6), Akbari et al. (14), and Mianehsaz et al. (1) and was contrary to the results of studies by Choobineh et al. (5), Mirmohammadi et al. (30), and Gorgi et al. (29). In justifying the lack of relationship between age and work experience with MSDs in this study, it can be said that although occupational risk factors have cumulative effects with increasing age and the role of other effective factors in this field, whether other harmful factors or preventive factors, such as employees' knowledge of ergonomics, doing exercises during office work, and work hours with computers during work shifts (28), has diminished the role of age and work experience.

According to the results of this study, there was no significant relationship between body mass index (BMI) and MSDs, which is similar to the results of studies by Tirgar et al. (2) and Mianehsaz et al. (1) and contrary to the results of a study by Choobineh et al. (5). Obesity is one of the causes of reduced mobility among employees and increased pressure on the body's muscles and skeleton and is a risk factor for MSDs, especially in the lower back and lower organs (23, 33). Therefore, probably for this reason, in this study and studies where the most common MSDs were in the neck (1, 2), no significant relationship was observed between MSDs and BMI.

In this study, there was no significant relationship between marital status and MSDs. This finding is similar to the results of other studies (1, 5, 14, 23, 29). In the present study, there was no significant relationship between MSDs and employees' workplaces. In James et al.' study on faculty members and staff of five faculties of the University of Newcastle, Australia, there was no difference between the MSDs of the staff who worked in the administrative and management sector and the training staff (22). The results of Griffiths et al.' study on 934 public sector employees in Australia also showed that only wrist pain was more common among typists than other employees, and the MSDs of other body parts were not significantly different among the employees of different departments (28).

In the present study, the results of the ergonomic risk factors of the workstation (based on the ROSA score) showed that 62.9% of the workstations were in a dangerous

Table 4. Relationship of the Cornell Score with Demographic Variables and Rapid Office Strain Assessment's Score

Variables	Cornell Score (Median (IQR))	Cornell Score (Mean Rank)	Correlation Coefficient	P-Value (Crude)	P-Value (Adjusted) [a]
Gender				0.030 [b]	0.025
Male	21.5 (80.25)	57.10			
Female	63.5 (180.5)	72.05			
Age (y)				0.117 [c]	-
< 35	18 (80.50)	55.34			
35 - 40	63 (103.5)	67.31			
> 40	63.5 (186.5)	72.23			
Body mass index (kg/m^2)				0.031 [c]	
Thin/normal	18.25 (96.12)	55.97			Reference
Overweight	65.5 (184.25)	70.62			0.108
Obese	64.25 (155.75)	79.60			0.104
Marital status				0.025 [b]	0.094
Single	15.5 (69)	50.22			
Married	59 (177)	69.94			
Educational level				0.259 [b]	
Diploma/associate	85 (237.5)	76.40			
Bachelor's and higher	55 (118.38)	64.66			-
Workplace unit				0.464	
Headquarters	56 (126.63)	63.99			
Educational	56.25 (166.88)	68.86			
Work experience (y)				0.431 [c]	
< 10	41 (104.25)	64.14			
10 - 15	42 (103.5)	61.12			
16 - 20	77.75 (186.25)	77.07			
> 20	56 (161.25)	69.14			-
Chair					-
Seat pan height			-0.042	0.629 [d]	
Seat pan depth			-0.019	0.832 [d]	
Armrests			-0.107	0.223 [d]	
Back support			0.048	0.586 [d]	
Total			0.009	0.915 [d]	
Monitor and telephone					
Monitor			0.146	0.095 [d]	
Telephone			0.122	0.162 [d]	
Total			0.157	0.073 [d]	-
Mouse and keyboard					
Mouse			0.066	0.453 [d]	
Keyboard			0.097	0.269 [d]	
Total			0.071	0.420 [d]	-
Total score (ROSA)			0.044	0.615 [d]	-

Abbreviations: IQR, interquartile range; ROSA, rapid office strain assessment.
[a] Non-parametric regression (gender, body mass index, and marital status as independent variables).
[b] Mann-Whitney U test.
[c] Kruskal-Wallis H test.
[d] Spearman's rank correlation test.

state, and 37.1% of the cases were in a warning state. In Ferasati et al.'s study, warning and danger cases were 31% and 48% (13), 28% and 51% in Ghanbary-Sartang and Habibi's study (12), 29.2% and 70.8% in Salehi Sahlabadi et al.'s study (11), and 36.4% and 63.6% in Mirmohammadi et al.'s study (30), respectively. The results of the present

Table 5. Relationship of Organ Discomfort Score with Rapid Office Strain Assessment's Score [a]

Organ	Chair	Monitor	Telephone	Monitor and Telephone	Mouse	Keyboard	Mouse and Keyboard	Total Score (ROSA)
Neck	0.042 (0.634)	0.197 (0.023)	0.039 (0.659)	0.139 (0.111)	0.140 (0.108)	0.079 (0.368)	0.086 (0.326)	0.079 (0.366)
Shoulder								
Right	-0.002 (0.980)	0.007 (0.938)	0.008 (0.928)	-0.007 (0.936)	0.091 (0.300)	0.102 (0.246)	0.108 (0.220)	0.040 (0.652)
Left	0.010 (0.906)	0.047 (0.593)	0.103 (0.239)	0.080 (0.365)	0.040 (0.647)	0.061 (0.485)	0.055 (0.530)	0.051 (0.562)
Upper back	0.047 (0.595)	0.237 (0.006)	0.048 (0.581)	0.191 (0.029)	0.075 (0.390)	0.095 (0.278)	0.027 (0.755)	0.060 (0.497)
Arm								
Right	0.088 (0.315)	0.080 (0.361)	0.054 (0.540)	0.049 (0.577)	0.071 (0.420)	-0.008 (0.927)	0.026 (0.763)	0.122 (0.164)
Left	-0.013 (0.885)	0.102 (0.243)	0.109 (0.214)	0.109 (0.213)	0.072 (0.412)	-0.001 (0.987)	0.053 (0.549)	0.031 (0.727)
Lower back	0.007 (0.938)	0.119 (0.175)	0.154 (0.077)	0.150 (0.085)	0.030 (0.732)	0.083 (0.346)	0.051 (0.559)	0.022 (0.804)
Forearm								
Right	0.114 (0.193)	0.212 (0.015)	0.024 (0.780)	0.158 (0.071)	0.062 (0.481)	-0.091 (0.299)	-0.006 (0.944)	0.120 (0.172)
Left	-0.021 (0.814)	0.247 (0.004)	0.126 (0.151)	0.253 (0.003)	0.065 (0.456)	-0.027 (0.761)	0.023 (0.791)	-0.015 (0.862)
Wrist								
Right	0.039 (0.655)	0.038 (0.668)	0.034 (0.696)	0.090 (0.302)	0.022 (0.804)	0.040 (0.647)	0.060 (0.497)	0.051 (0.561)
Left	-0.143 (0.102)	0.082 (0.349)	0.106 (0.227)	0.157 (0.073)	0.057 (0.514)	-0.110 (0.208)	-0.028 (0.753)	-0.125 (0.154)
Buttocks	0.014 (0.872)	0.289 (0.001)	0.179 (0.040)	0.266 (0.002)	0.007 (0.935)	0.011 (0.900)	0.001 (0.995)	0.019 (0.829)
Thigh								
Right	0.040 (0.649)	0.246 (0.004)	0.227 (0.009)	0.290 (0.001)	-0.040 (0.652)	-0.015 (0.865)	-0.041 (0.639)	0.027 (0.763)
Left	0.023 (0.790)	0.253 (0.003)	0.213 (0.014)	0.295 (0.001)	-0.017 (0.846)	-0.027 (0.754)	-0.059 (0.502)	0.021 (0.814)
Knee								
Right	0.0001 (0.997)	0.056 (0.520)	0.079 (0.366)	0.133 (0.129)	-0.002 (0.980)	-0.036 (0.680)	0.008 (0.929)	-0.002 (0.980)
Left	0.002 (0.981)	0.019 (0.832)	0.117 (0.180)	0.109 (0.213)	-0.091 (0.300)	0.025 (0.775)	-0.002 (0.985)	0.003 (0.969)
Leg								
Right	0.031 (0.726)	0.137 (0.116)	0.104 (0.236)	0.187 (0.032)	-0.144 (0.100)	-0.053 (0.543)	-0.102 (0.245)	0.041 (0.643)
Left	0.054 (0.538)	0.103 (0.242)	0.115 (0.191)	0.171 (0.050)	-0.042 (0.629)	0.008 (0.929)	-0.042 (0.632)	0.088 (0.313)
Ankle								
Right	0.078 (0.374)	0.218 (0.012)	0.055 (0.530)	0.262 (0.002)	0.062 (0.483)	0.164 (0.061)	0.145 (0.098)	0.112 (0.202)
Left	0.031 (0.724)	0.110 (0.210)	0.121 (0.167)	0.174 (0.046)	0.044 (0.619)	0.052 (0.555)	0.030 (0.737)	0.038 (0.663)

Abbreviation: ROSA, rapid office strain assessment.
[a] The data in the table are reported as correlation coefficient (P-value).

study are more worrying than other similar studies, and a higher percentage of workstations are unsafe. In finding the cause of these ergonomic risk factors, it can be said that in addition to the standard equipment and their arrangement in workstations, other factors, such as the knowledge of employees in the field of ergonomics, the time of the observer's visit to the workstation, accuracy, and skill of the observer in completing the ROSA checklist, play a role in the obtained score. In this study, the evaluations were conducted by a senior occupational health expert on the first three days of the week, in the first 4 hours of the work shift, and only during the first visit to the person. Information about these cases is not available in other aforementioned studies.

In this study, examining the relationship between MSDs and ergonomic risk factors of the workstation showed that the discomfort scores related to the vertebral column, shoulder girdle, forearm, lower back, and lower organ had a significant positive relationship with the ergonomic risk score related to the monitor, which emphasizes the importance of this part of the workstation. In other cases, there was no significant relationship between MSDs and ROSA scores. In Ye et al.'s study, the condition of the monitor (not placing the monitor in front of the user) is mentioned as a critical risk factor for neck pain and lower back pain in computer users (3). In Ebrahimi Hariri et al.'s review, there was a significant relationship between neck and shoulder pain with the ergonomic position of the monitor and phone and between wrist and forearm pain with the ergonomic position of the mouse and keyboard. However, there was no statistically significant correlation between the final score of ROSA and MSDs (9). In a study, pains in the neck and upper back were related to the monitor's position, and pains in the hands were related to the keyboard (13). In Mirmohammadi et al.'s study, a significant relationship was noticed only between the MSDs of the lower back region and chair score in the ROSA checklist (30). The results of Akbari et al.'s study demonstrated the absence of a significant relationship between the ergonomic risk factors of the workstation and the MSDs of employees (14).

5.1. Limitations

There were some limitations in this study, including the employees' broad age range and work experiences. Additionally, the researchers did not control some variables, such as analgesic consumption, the MSDs were self-reported, and the samples were not evaluated by physical examinations. Moreover, because the researchers assessed workstations using the ROSA checklist in person and not by video, some participants might consciously or unconsciously have taken the proper positions during assessments.

5.2. Conclusions

The most widely recognized MSDs were neck, lower back, and upper back pain, respectively. Female employees had more MSDs. Consequently, it is necessary to teach sports exercises to reinforce core muscles, particularly for female employees. All workstations (100%) were in an unsafe position, and the MSDs of the vertebral column, shoulder girdle, forearm, lower back, and lower organ were related to the position of the monitor. Accordingly, corrective interventions, particularly the adjustment of monitor placement in office workstations, are fundamental.

It is suggested to more closely examine the relationship between the ergonomic risk factors of the workstation and the MSDs of office workers. It is necessary to consider other possible effective variables, such as the knowledge of the employees about the principles of office ergonomics, working hours with the computer during the day, steady or variable office tasks of individuals during the day or the years, psychosocial factors, and general health status (e.g., nutrition, physical activity, and smoking). It is likewise recommended to carry out further studies to investigate the causes of more MSD complaints in females than males.

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Footnotes

Authors' Contribution: D. Z. developed the original idea and the protocol. H. S. wrote the manuscript and participated in designing the evaluation. M. J. A. wrote the manuscript and performed the statistical analyses. E. M. contributed to the development and revision of the idea. M. S. S. and A. A. prepared additional data for the evaluation.

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