

Evaluating Musculoskeletal Disorders and Their Ergonomic Risk Factors among Office Workers of a Large Public Hospital in Iran

Elaheh Mianehsaz^{1,2}, Mehrnaz Tabatabaei³, Masoud Motalebi Kashani⁴, Hakime Zamani Badi⁵, Habibollah Rahimi⁶

¹Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Kashan University of Medical Sciences, Kashan, ²Trauma Research Center, Kashan University of Medical Sciences, Kashan, ³Student of Medicine, Faculty of Medicine, Kashan University of Medical Sciences, Kashan, ⁴Social Determinates of Health Research Center, Kashan University of Medical Sciences, Student of Medicine, Faculty of Medicine, Kashan University of Medical Sciences, Kashan, IR Iran, ⁵Departments of Health, Safety and Environment Management, Kashan University of Medical Sciences, Kashan, ⁶Department of Biostatistics and Epidemiology, School of Public Health, Kashan University of Medical Sciences, Kashan, Iran

ORCID:

Elaheh Mianehsaz: <http://orcid.org/0000-0002-3430-6767>

Hakime Zamani-Badi: 0000-0001-7891-9269

Abstract

Aims: Musculoskeletal disorders (MSDs) are injuries in the musculoskeletal system which is also named as “repetitive stress injury” or “overuse injury”. Inattention to the principles of ergonomics at work is associated with different MSDs. This study evaluated MSDs and their ergonomic risk factors among office workers in a large public hospital in Iran. **Materials and Methods:** This cross-sectional study was conducted in 2019. Participants were 111 office workers of Shahid Beheshti Hospital, Kashan, Iran. Data were collected using the Cornell Musculoskeletal Discomfort Questionnaire and the Rapid Office Strain Assessment. The SPSS software (v. 20) and the STATA software were used for data analysis, using *t*-test and linear regression. **Results:** Most participants were female (55.9%) and had experienced MSDs during the past week (76%). Subject analysis revealed significant differences in vertebral column’s MSDs versus limbs and right-sided limbs versus left ones ($P < 0.001$). The most common MSDs among participants were in the neck (67.6%), lower back (59.5%), and upper back (55%). MSDs among females were significantly more than males ($P < 0.05$). MSDs in the lower back among overweight and obese participants were significantly more than others ($P < 0.05$). Respecting the chair-related ergonomic risk factors for MSDs, 24% of participants were at high risk and 75% of them were at moderate risk. **Conclusion:** Office workers were at moderate risk for MSDs. Providing education about the principles of ergonomics can reduce their MSDs.

Keywords: Ergonomics, musculoskeletal disorders, Rapid Office Strain Assessment

INTRODUCTION

Musculoskeletal disorders (MSDs) are the second most prevalent work-related disorders surpassed by respiratory disorders.^[1] MSDs are caused by a wide range of factors which affect the muscles, tendons, ligaments, joints, and peripheral nerves and vessels and result in pain, discomfort, numbness, feeling of heaviness, and tissue injuries in different parts of the body.^[2,3] In recent decades, the prevalence of MSDs has significantly increased to 60% among office workers due to the increasing use of computer.^[4-7]

MSDs result in the loss of working hours, increase work-related costs, cause injuries to workforce, and are the

main reason for more than 50% of absences from work^[8] and one-third of requests for worker’s compensation.^[8,9] Estimates show that the direct and indirect costs of MSDs are around 1% of the gross domestic product of industrial countries.^[10]

MSDs are highly prevalent among office workers. The major ergonomic risk factors for MSDs during office work are improper postures, static positions, contact, improper

Address for correspondence: Dr. Hakime Zamani Badi, Department of Health, Safety and Environment Management, Faculty of Health, Kashan University of Medical Sciences, Kashan, Iran. E-mail: hakime2326@gmail.com

Received: 27-Apr-2021

Revised: 30-Jul-2021

Accepted: 25-Dec-2021

Published: 29-Mar-2022

Access this article online

Quick Response Code:



Website:
<http://iahs.kaums.ac.ir>

DOI:
10.4103/iahs.iahs_68_21

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Mianehsaz E, Tabatabaei M, Kashani MM, Badi HZ, Rahimi H. Evaluating Musculoskeletal Disorders and Their Ergonomic Risk Factors among Office Workers of a Large Public Hospital in Iran. *Int Arch Health Sci* 2022;9:35-40.

placement of equipment, and doing repetitive movement while using keyboard or mouse.^[11-17]

Previous studies reported different results regarding the most prevalent MSD among computer users and office workers.^[13,18] For example, a study in China on office workers reported back pain as the most prevalent MSD.^[6] Another study on computer users in Iran showed that 75% of computer users occasionally experienced MSDs and 20%–25% of them had daily experience of MSDs, while pain in the neck and the trunk was the most prevalent MSD.^[19] Moreover, a study on students who used laptop and computer showed that 52.8% of them suffered from MSDs, with neck pain as the most common MSD.^[20]

Work-related risk factors for MSDs have cumulative effects and can gradually cause injuries to the musculoskeletal system. Therefore, early identification and management of MSDs can help their early prevention, ensure workplace health and safety, and reduce MSD-related costs.^[17] The present study was conducted to evaluate MSDs and their ergonomic risk factors among office workers in a large public hospital in Iran.

MATERIALS AND METHODS

This cross-sectional study was conducted in 2019. Participants were all office workers of Shahid Beheshti Hospital, Kashan, Iran, who had a work experience of at least 1 year and used computers and telephones during their work. Participants with congenital disorders, history of nonwork-related injuries, and maternity leave were not included. There were 120 office workers and 111 of them were included in the study.

Initially, participants were asked to complete the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). Then, an assessor used the Rapid Office Strain Assessment (ROSA) checklist to assess their posture and workplace characteristics.

CMDQ was 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).^[21] Pain and discomfort in 12 parts of body are assessed in terms of severity, frequency, and degree of interference with the ability to work.

The ROSA checklist is a method for the rapid assessment of ergonomic risk factors for MSDs at office workplace.^[21] The possible total score of this checklist is 1–10 which is interpreted as low risk with no need for intervention (scores 0–3), moderate risk (scores 3–5), and high risk with the need for immediate intervention (scores 6–10).

Data obtained from the above questionnaire and checklist were analyzed using the SPSS software (v. 20.0). IBM SPSS Armonk, NY: IBM Corp. USA. Comparison between the upper and the lower limbs, between the right and the left sides of the body, and between different groups of participants was performed using the paired-sample *t* test. Moreover, the STATA software was used to assess the relationships of MSDs

with demographic characteristics through the linear regression analysis. The level of significance was set at <0.05.

Ethical considerations: The Ethics Committee approved this study (code: 1R.KAUMS.MEDNT.REC.1399.004). Participants were ensured of confidential data management and their ability to access the study findings. Written informed consent was obtained from them.

RESULTS

In total, 111 office workers of Shahid Beheshti public hospital participated in and completed the study. Most participants were female (55.9%) and married (84.7%) and had bachelor's degree. Table 1 provides detailed information about their demographic characteristics.

The results of MSD assessment using CMDQ showed that 76% of participants had experienced MSDs during the past week, 40.5% of them had referred to physicians due to MSDs during the past 1 year before the study, 20% needed medical leave, and 26.1% had used physical therapy services. Almost one-half of the participants noted that MSDs may finally result in their organizational turnover and reported staff shortage in their department. Moreover, 45.5% of them noted that MSDs

Table 1: Participants' demographic characteristics

Characteristics	n (%)
Gender	
Male	49 (44.1)
Female	62 (55.9)
Age (years)	
<30	15 (13.5)
30-35	31 (27.9)
36-40	31 (27.9)
>40	34 (30.7)
Body mass index	
18.5-24.9 (normal)	57 (51.8)
25-29.9 (overweight)	40 (36.4)
>30 (obese)	13 (11.8)
Marital status	
Single	17 (15.3)
Married	94 (84.7)
Number of children	
0	13 (14.9)
1	26 (29.9)
2	38 (43.7)
More	10 (11.5)
Educational level	
Below diploma	1 (0.9)
Diploma	9 (8.2)
Associate degree	9 (8.2)
Bachelor's degree and higher	91 (82.7)
Work experience at the current position (years)	
<5	27 (27.3)
5-10	30 (30.3)
>10	42 (42.4)

had reduced their productivity at work. Furthermore, the results showed that the most prevalent MSDs during the past 1 week before the study were related to the neck (67.6%), the lower back (59.5%), and the upper back (55.0%). Forty percent of participants with neck pain reported severe pain and 38.7% of them reported the great effects of neck pain on their work. Moreover, 31.8% of participants with lower back pain reported its great severity and 34.8% of them noted the great effects of lower back pain on their work. Finally, 24.6% of participants with upper back pain noted that their pain was severe and 27.9% of them reported the great effects of that pain on their work [Table 2].

The results of the paired-sample *t*-test showed that the mean score of MSDs for the vertebral column was significantly greater than the limbs (20.55 ± 23.11 vs. 7.34 ± 12.77; *P* < 0.001). Moreover, the mean score of MSDs for the right limbs of the body was significantly

greater than the left limbs (8.55 ± 15.52 vs. 6.13 ± 12.89; *P* < 0.05) [Table 3].

Assessment of the relationship of MSDs with participants' demographic characteristics showed lower back pain among overweight or obese participants were significantly greater than those with normal body mass index (71.1% vs. 49.1%) (*P* = 0.016).

In order to assess the relationship of the amount of MSDs with demographic characteristics, the pain severity scores of all parts were summed and entered into the linear regression model as a dependent variable. The results of the regression analysis revealed that only gender was a significant predictor of MSDs so that after adjusting the effects of other demographic characteristics, pain severity among female participants was significantly greater than male participants [*P* = 0.02; Table 4].

Assessment of the ergonomic risk factors for MSDs using the ROSA checklist revealed that the highest risk was related to

Table 2: The frequency and severity of musculoskeletal disorders in different parts of the body and their interference with the ability to work based on Cornell Musculoskeletal Discomfort Questionnaire

Limbs	Scores											Total score
	Frequency of MSDs					Severity of MSDs			Interference of pain MSDs with the ability to work			
	0*	1.5	3.5	5	10	1**	2	3	1***	2	3	
Neck	36 (32.4)	21 (28)	8 (10.7)	12 (16.0)	34 (45.3)	17 (22.7)	28 (37.3)	30 (40.0)	9 (12.0)	37 (49.3)	29 (38.7)	25.47
Shoulder												
Right	64 (57.7)	17 (36.2)	3 (6.4)	10 (21.2)	17 (36.2) [†]	13 (27.7)	23 (48.9)	11 (23.4)	11 (23.4)	24 (51.1)	12 (25.5) [†]	12.13 [†]
Left	70 (63.6)	12 (29.2)	7 (17.1)	9 (22.0)	13 (31.7)	13 (31.7)	20 (48.8)	8 (19.5)	10 (24.4)	21 (51.2)	10 (24.4)	9.25
Upper back	50 (45.0)	19 (31.1)	15 (24.6)	7 (11.5)	20 (32.8)	17 (27.9)	29 (47.5)	15 (24.6)	9 (14.7)	35 (57.4)	17 (27.9)	15.82
Arm												
Right	40 (65.6)	12 (46.2)	3 (11.5)	2 (7.7)	9 (34.6) [†]	9 (34.6)	12 (46.2)	5 (19.2) [†]	7 (26.9)	12 (46.2)	7 (26.9) [†]	5.92
Left	41 (67.2)	8 (33.3)	3 (12.6)	5 (20.8)	8 (33.3)	4 (16.7)	15 (62.5)	5 (20.8)	5 (20.8)	14 (58.4)	5 (20.8)	5.57
Lower back	45 (40.5)	18 (27.3)	13 (19.7)	8 (12.1)	27 (40.9)	15 (22.7)	30 (45.5)	21 (31.8)	9 (13.7)	34 (51.5)	23 (34.8)	20.32
Forearm												
Right	82 (73.9)	13 (44.8)	3 (10.4)	2 (6.9)	11 (37.9) [†]	10 (34.5)	12 (41.4)	7 (24.1) [†]	8 (27.6)	14 (48.3)	7 (24.1) [†]	6.86 [†]
Left	88 (79.3)	10 (43.5)	2 (8.7)	5 (21.7)	6 (26.1)	10 (43.5)	10 (43.5)	3 (13.0)	7 (30.5)	13 (56.5)	3 (13.0)	4.18
Wrist												
Right	74 (66.7)	13 (35.2)	4 (10.8)	4 (10.8)	16 (43.2)	7 (19.0)	15 (40.5)	15 (40.5)	3 (8.1)	19 (51.4)	15 (40.5)	11.92 [†]
Left	85 (76.6)	8 (30.8)	6 (23.0)	4 (15.4)	8 (30.8)	6 (23.0)	13 (50.1)	7 (26.9)	4 (15.4)	16 (61.6)	6 (23.0)	5.99
Buttocks	82 (73.9)	9 (31.0)	6 (20.7)	5 (17.3)	9 (31.0)	9 (31.0)	10 (34.5)	10 (34.5)	6 (20.7)	17 (58.6)	6 (20.7)	7.33
Thigh												
Right	84 (75.7)	9 (33.4)	6 (22.2)	4 (14.8)	8 (29.6) [†]	8 (29.6)	13 (48.2)	6 (22.2) [†]	10 (37.0)	13 (48.2)	4 (14.8) [†]	5.49
Left	91 (82.0)	8 (40.0)	4 (20.0)	2 (10.0)	6 (30.0)	7 (35.0)	9 (45.0)	4 (20.0)	8 (40.0)	9 (45.0)	3 (15.0)	3.82
Knee												
Right	71 (64.0)	15 (37.5)	5 (12.5)	4 (10.0)	16 (40.0)	13 (32.5)	17 (42.5)	10 (25.0)	10 (25.0)	19 (47.5)	11 (27.5)	10.60
Left	77 (69.4)	15 (44.1)	6 (17.6)	4 (11.8)	9 (26.5)	14 (41.2)	13 (38.2)	7 (20.6)	11 (32.4)	17 (50.0)	6 (17.6)	6.63
Leg												
Right	85 (76.6)	9 (34.6)		7 (26.9)	10 (38.5)	6 (23.1)	12 (46.1)	8 (30.8)	6 (23.1)	14 (53.8)	6 (23.1)	7.70
Left	86 (77.5)	10 (40.0)	1 (4.0)	7 (28.0)	7 (28.0)	8 (32.0)	8 (32.0)	9 (36.0)	7 (28.0)	12 (48.0)	6 (24.0)	6.22
Ankle												
Right	84 (75.7)	5 (18.6)	4 (14.8)	7 (25.9)	11 (40.7)	7 (25.9)	11 (40.7)	9 (33.4)	6 (22.2)	14 (51.9)	7 (25.9)	7.83
Left	85 (76.6)	7 (26.9)	4 (15.4)	5 (19.2)	10 (38.5)	7 (26.9)	10 (38.5)	9 (34.6)	8 (30.8)	11 (42.3)	7 (26.9)	7.42

*Scores are as follows: 0: Never, 1.5: 1-3 times last week, 3.5: 3-4 times last week, 5: Once every day, 10: Several times every day, **Scores are as follows: 1: Slightly uncomfortable, 2: Moderately uncomfortable, 3: Very uncomfortable, ***Scores are as follows: 1: Not at all, 2: Slightly interfered, [†]*P* < 0.05, using *Mc Nemar* and paired *t*-tests

the chair part of the workstation so that 24% of participants were at high risk and 74% were at moderate risk for MSDs due to inappropriate chair use. The risk for MSDs due to the use of monitors, telephones, mouses, and keyboards was at low level. Respecting the total risk associated with computer use, 76.6% of participants were at moderate risk and 23.4% of them were at high risk for MSDs. Moreover, the total mean score of the ROSA checklist was 4.67 ± 1.15 (in the possible range of 0–10), showing moderate risk for MSDs [Table 5].

DISCUSSION

This study evaluated MSDs and their ergonomic risk factors among office workers in a large public hospital in Iran. Findings showed that almost half of the participants had referred to a physician during the past 1 year before the study due to MSDs. Moreover, most of them reported MSDs during the past 1 week in the neck (67.6%), lower back (59.5%), and upper back (55.0%). Two former studies also reported MSDs in the neck and the lower back as the most prevalent MSDs among office workers.^[22,23] Studies on nurses also reported that they had MSDs mostly in the lower back area.^[24,25] The most common reasons for the high prevalence of MSDs in the neck and the lower back areas are improper and static postures at work, inappropriate design of workstations, and repetitive movements while using mouse and keyboard.^[26-28]

We also found that MSDs in right-sided limbs were more common than the left-sided limbs. This finding is attributable to the dominance of the right hand and leg in most people and they use the right upper limbs in office works (typing, using a mouse, and transferring papers and files) and the right lower limb as a support in various movements.

The study findings also showed that the prevalence of MSDs among female office workers was significantly greater than their male counterparts. Several earlier studies also reported the same finding.^[29-31] It may be due to the fact that most office workstations are designed based on the anthropological characteristics of men as well as smaller body and muscle mass of women compared with men.^[32]

Findings showed that the prevalence of MSDs in the lower back among overweight and obese participants was higher than other participants. This finding implies the contribution of obesity to the development of MSDs. Obesity is associated with reduced mobility, muscular weakness, and higher risk of using improper body positions, and hence contributes to MSDs. Moreover, obese people need to bear the greater weight of their bodies which causes them pain and fatigue.^[33,34] The higher prevalence of MSDs among overweight and obese people highlights the necessity of recommending them to reduce weight, providing them with education about the principles of ergonomics, and modifying ergonomic risk factors for MSDs in their workstations.

The study findings also indicated that except for the significantly higher prevalence of MSDs in the left thigh

Table 3: The comparison of musculoskeletal disorders score between body parts

Variables	Mean±SD	P	CI	
			Lower bound	Upper bound
Vertebral column	20.55±23.11	<0.001	-17.08	-0.9.33
Limbs	7.34±12.77			
Right limbs	8.55±15.52	<0.001	0.22	4.61
Left limbs	6.13±12.89			

CI: Confidence interval, SD: Standard deviation

Table 4: The results of the linear regression analysis for assessing the relationship of musculoskeletal disorders with demographic characteristics

Variables	Coefficient	P	CI	
			Lower bound	Upper bound
Age (years)	-1.88	0.72	-12.14	8.44
Body mass index	1.38	0.85	-13.96	16.73
Work experience	2.98	0.56	-7.29	13.25
Gender				
Male	-	-	-	-
Female	125.88	0.02	13.95	237.82
Marital status				
Single	-	-	-	-
Married	-72.65	0.37	-233.99	88.68
Educational level				
Diploma	-	-	-	-
Associate degree	-90.20	0.51	-366.73	186.31
Bachelor's degree and higher	-32.07	0.77	-250.56	186.41
Constant	2.47	0.84	-22.07	27.03

CI: Confidence interval

Table 5: The results of assessing the ergonomic risk factors for musculoskeletal disorders using the Rapid Office Strain Assessment checklist

Dimensions	n (%)	Mean±SD
Chair		
Low risk (<3)	1 (0.9)	4.64±1.20
Moderate risk (3-5)	83 (74.8)	
High risk (>5)	27 (24.3)	
Monitor and telephone		
Low risk (<3)	79 (71.2)	2.22±0.68
Moderate risk (3-5)	32 (28.8)	
High risk (>5)	0	
Mouse and keyboard		
Low risk (<3)	31 (27.9)	2.96±1.03
Moderate risk (3-5)	79 (71.2)	
High risk (>5)	1 (0.9)	
Total		
Low risk (<3)	0	4.67±1.15
Moderate risk (3-5)	85 (76.6)	
High risk (>5)	26 (23.4)	

SD: Standard deviation

among participants with younger participants, other MSDs had no significant relationships with participants' age and work experience. A former study also reported the same finding.^[35] However, a study showed that the risk of MSDs increases with work experience.^[32] The insignificant relationship of MSDs with age and work experience in the present study may be due to the fact that most participants were young workers with a mean age of 37.58 ± 7.61 years. The effects of MSD risk factors are usually cumulative and appear after a long time. Moreover, office workers with more severe MSDs in the study setting might have changed their job or workplace before the present study and were not available for inclusion in the study.

One of the limitations of this study is that some participants might consciously or unconsciously have taken proper position during ergonomic risk factor assessment using the ROSA checklist.

CONCLUSION

The high prevalence of MSDs and the ergonomic risk factors might have been due to nonstandard equipment, inappropriate use of equipment, inadequacy of educational programs on the principles of ergonomics for office workers, and their poor positional habits. As MSDs in the neck and the lower back were more prevalent than other types of MSDs in the study setting, strategies such as placing office workers' monitors in an appropriate position and height, using standard chairs with good lumbar curve and armrest, and providing them with quality education about not cradling a telephone between the ear and the shoulder are recommended to reduce the risk of MSDs in these areas.

Acknowledgments

The authors thank the Deputy Director of Research, Kashan University of Medical Sciences, Iran, for financial support of this research. We sincerely appreciate the cooperation of the staff of the Shahid Beheshti hospital at Kashan Medical Sciences University, who helped the researchers to carry out this research.

Financial support and sponsorship

This study was financially supported by Deputy Director of Research, Kashan University of Medical Sciences, Iran.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Organization WH. WHO Global Plan of Action on Workers' Health (2008-2017): Baseline for Implementation. Geneva: World Health Organization; 2013.
2. Tirgar A, Khallaghi S, Taghipour M. A study on musculoskeletal disorders and personal and occupational risk factors among surgeons. *Iran J Health Sci* 2013;1:50-7.
3. Oh IH, Yoon SJ, Seo HY, Kim EJ, Kim YA. The economic burden of musculoskeletal disease in Korea: A cross sectional study. *BMC Musculoskelet Disord* 2011;12:157.
4. Griffiths KL, Mackey MG, Adamson BJ, Pepper KL. Prevalence and risk factors for musculoskeletal symptoms with computer based work

- across occupations. *Work* 2012;42:533-41.
5. Robertson MM, Ciriello VM, Garabet AM. Office ergonomics training and a sit-stand workstation: Effects on musculoskeletal and visual symptoms and performance of office workers. *Appl Ergon* 2013;44:73-85.
6. Shariat A, Cardoso JR, Cleland JA, Danaee M, Ansari NN, Kargarfard M, et al. Prevalence rate of neck, shoulder and lower back pain in association with age, body mass index and gender among Malaysian office workers. *Work* 2018;60:191-9.
7. Tirgar A, Aghalari Z, Salari F. Musculoskeletal disorders & ergonomic considerations in computer use among medical sciences students. *J Ergon* 2014;1:55-64.
8. Morata T, Levy B, Wegman D, Baron S, Sokas R. Hearing disorders. *Occupational and Environmental Health: Recognizing and Preventing Disease and Injury*. Philadelphia: Lippincott Williams & Wilkins; 2006. p. 587-96.
9. Mousavi Anijdan S, Tirgar A. Assessment of affecting factors on personal computers power consumption in an academic center in 2014: A short report. *J Rafsanjan Univ Med Sci* 2015;14:525-32.
10. Coluci MZ, Alexandre NM, de Freitas Pedrini T. Musculoskeletal symptoms and workers' perception about job factors in a pulp and paper industry. *Work* 2012;41 Suppl 1:5728-30.
11. Zarei E, Dormohammadi A, Normohammadi M, Sarsangi V. Risk assessment of computer users' upper musculoskeletal limbs disorders in a power company by means of RULA method and NMQ. *J Sabzevar Univ Med Sci* 2014;20:521-9.
12. Nadri H, Nadri A, Khanjani N, Nadri F, Roodbandi Jafari A. Evaluating the factors effective on musculoskeletal disorders among the employees of one of Qazvin's governmental offices. *J Health Dev* 2013;2:106-16.
13. Mehrdad R, Dennerlein JT, Haghghat M, Aminian O. Association between psychosocial factors and musculoskeletal symptoms among Iranian nurses. *Am J Ind Med* 2010;53:1032-9.
14. Dehghan N, Choobineh AR, Hasanzadeh J. Interventional ergonomic study to correct and improve working postures and decrease discomfort in assembly workers of an electronic industry. *Iran Occupational Health*. 2013;9.
15. Azizi M, Motamedzade M. Working postures assessment using rula and ergonomic interventions in quality control unit of a glass manufacturing company. *Iran J Ergon* 2013;1:73-9.
16. Sonne M, Villalta DL, Andrews DM. Development and evaluation of an office ergonomic risk checklist: ROSA – Rapid Office Strain Assessment. *Appl Ergon* 2012;43:98-108.
17. Choobineh A, Rahimifard H, Jahangiri M, Mahmoodkhani S. Musculoskeletal injuries and their associated risk factors in office workplaces. *Iran Occup Health* 2012;8:70-81.
18. Tinubu BM, Mbada CE, Oyeyemi AL, Fabunmi AA. Work-related musculoskeletal disorders among nurses in Ibadan, south-west Nigeria: A cross-sectional survey. *BMC Musculoskelet Disord* 2010;11:1-8.
19. Yektaee T, Tabatabaee Ghomshe F, Piri L. The effect of ergonomic principles education on musculoskeletal disorders among computer users. *J Rehabil* 2013;13:108-16.
20. Dockrell S, Bennett K, Culleton-Quinn E. Computer use and musculoskeletal symptoms among undergraduate university students. *Comput Educ* 2015;85:102-9.
21. Aftehzadeh-Kashani HC, Bakand S, Gohari MR, Abbastabar H, Moshtaghi P. Validity and reliability of farsi version of Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). *Iran Occup Health* 2011;7:69-75.
22. Choobineh A, Rahimi Fard H, Jahangiri M, Mahmood Khani S. Musculoskeletal injuries and their associated risk factors. *Iran Occup Health* 2012;8:70-81.
23. Saeidi C, Dastaran S, Musavi S. Evaluation of the risk factors of musculoskeletal disorders and its relation to the workload of employees at 118 call center in Sanandaj, Iran. *Health Dev J* 2020;5:110-21.
24. Soroush A, Shamsi M, Izadi N, Heydarpour B, Samadzadeh S, Shahmohammadi A. Musculoskeletal disorders as common problems among Iranian nurses: A systematic review and meta-analysis Study. *Int J Prev Med* 2018;9:27.
25. Barzideh M, Choobineh AR, Tabatabaee HR. Job stress dimensions and their relationship to musculoskeletal disorders in Iranian nurses. *Work* 2014;47:423-9.

26. Rodrigues MS, Sonne M, Andrews DM, Tomazini LF, Sato TO, Chaves TC. Rapid Office Strain Assessment (ROSA): Cross cultural validity, reliability and structural validity of the Brazilian-Portuguese version. *Appl Ergon* 2019;75:143-54.
27. Gholami T, Maleki Z, Ramezani M, Khazraee T. Application of ergonomic approach in assessing musculoskeletal disorders risk factors among administrative employees of medical university. *Int J Musculoskelet Pain Prev* 2018;3:1-5.
28. Pirmoradi Z, Golmohammadi R, Faradmal J, Motamedzade M. Artificial lighting and its relation with body posture in office workplaces. *J Ergon* 2018;5:9-16.
29. Hashemi M, Halvani GH, Askarishahi M, Tajvar A, Vahdani F, Mehrparvar AM. Study of musculoskeletal disorders prevalence and its related factors in by ROSA technique in administrative staff of minab Health centers. *Occup Med Q J* 2020;12:1-12.
30. Lorusso A, Bruno S, Caputo F, L'Abbate N. Risk factors for musculoskeletal complaints among microscope workers. *G Ital Med Lav Ergon* 2007;29:932-7.
31. Salehi Sahlabadi A, Karim A, Khatabakhsh A, Soori H. Ergonomic evaluation of office staff by Rapid Office Strain Assessment method and its relationship with the prevalence of musculoskeletal disorders. *J Health* 2020;11:223-34.
32. Ferasati F, Sohrabi M, Jalilian M. Evaluation of WMSDs in VDT users with Rapid Office Strain Assessment (ROSA) method. *Iran J Ergon* 2014;1:65-74.
33. Bolghanabadi S, Dehghan H, Pour M. The relationship between musculoskeletal disorders, stress and fatigue in the food industry employees. *Iran J Ergon* 2014;2:54-63.
34. Nadri H, Nadri A, Khanjani N, Nadri F, Jafari Roodbandi A. Evaluating the factors effective on musculoskeletal disorders among the employees of one of Qazvin's governmental offices. *Health Dev J* 2013;2:106-16.
35. Rowshani Z, Mortazavi SB, Khavanin A, Mirzaei R, Mohseni M. Comparing RULA and Strain index methods for the assessment of the potential causes of musculoskeletal disorders in the upper extremity in an electronic company in Tehran. *KAUMS J (FEYZ)* 2013;17:61-70.