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Risk Factors for Upper Extremity Musculoskeletal Disorders Among Office Workers in Qom Province, Iran

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Abstract

Background: The identification of the risk factors for musculoskeletal disorders (MSDs) is the first step in designing effective preventive interventions.
Objectives: To investigate the association between individual, organizational, physical, and psychological factors and upper extremity MSDs (i.e., shoulder, elbow and hand/wrist).
Materials and Methods: In this cross-sectional study, the study population was comprised of office workers from Qom Province, Iran. Of the 1630 Iranian office workers who were selected via a random multistage cluster sampling method, 1488 completed a comprehensive data collection form designed to investigate the individual, organizational, physical, and psychological factors related to MSDs (response rate: 91.3%).
Results: The predictors of shoulder MSDs in the past 12 months were uncomfortable sitting posture ($\beta = 0.42$, P = 0.04), limited rest breaks (β=0.73, P = 0.012), and no access to adjustable desks ($\beta = 0.43$, P = 0.018). Working on a computer for more than five hours ($\beta = 0.61$, P = 0.004) and an uncomfortable sitting posture ($\beta = 0.79$, P = 0.001) predicted hand/wrist symptoms.
Conclusions: Various risk factors in the workplace may contribute to MSDs in different upper extremities. Preventive interventions should hence include ergonomic and office equipment modifications.

Keywords: Musculoskeletal Diseases, Risk Factors, Shoulder, Elbow, Hand, Wrist

1. Background

Upper extremity musculoskeletal disorders (MSDs), including shoulder, elbow and hand/wrist disorders, are common complaints among office workers (1). Such disorders play an important role in work-related disabilities and sickness absences (2), and they hence lead to high costs for workers and society (3). In other words, MSDs have a great impact on workers' mental and physical health as well as their productivity (1, 3).

Office work typically involves activities such as reading, writing, and typing, which can be associated with prolonged static work posture, repetitive work movements, improper hand positioning, and improper lower arm support (4-6). Therefore, office workers are frequently subject to musculoskeletal impairment (7) and, as a result, MSDs among office workers are considered to be a major work-related health problem.

A highly effective treatment for MSDs is not yet known and so prevention is the best strategy with which to avoid the health, economic, and social consequences of MSDs (8). The first and the most important step in the prevention of MSDs (including upper extremity disorders) is identifying their risk factors (3). MSDs have a complex etiology (9) and there has been an increase in evidence suggesting the contribution of physical factors related to an individual's occupation (e.g., working postures), psychosocial factors (e.g., high job strain), organizational factors (e.g., work station design), and individual factors to MSDs among office workers (3, 10, 11). However, MSDs affecting different body regions are related to different risk factors, for example, the risk factors for shoulder disorders are not necessarily the same as those for hand or elbow disorders (11). Additionally, most studies on MSDs have been conducted in European countries and North America, and because of the difference in health, economic, and social systems, their results are not generalizable to countries such as Iran (12).

2. Objectives

The aim of this study was to investigate the individual, organizational, physical, and psychological factors associated with upper extremity MSDs among Iranian office workers.

3. Materials and Methods

A cross-sectional survey was conducted between September 2013 and May 2014 in Qom Province, central Iran. The participants were selected through stratified random sampling. After obtaining a list of all public offices and their office workers and dividing them based on gender (8% women vs. 92% men), a number was assigned to each worker. Then, the study samples were selected via a random number table. A sample of 1630 office workers (1500 men and 130 women) was selected from the list, with the proportion of men and women the same as that among all office workers. Of the invited participants, 1488 office workers completed the questionnaire, giving a response rate of 91.3%.

At least six months' residence in Qom province was the only eligibility criterion for the study. The study objectives were explained to the participants. They were informed that participation in the study was voluntary and that they could refuse to participate in the study at any time without consequences. Finally, written informed consent was obtained from all of the office workers who agreed to participate in the study. All data were considered confidential and all necessary ethical considerations were considered in this case. Approval was obtained from the Ethics Committee at Qom University of Medical Sciences (Ethical Code No. 28431, date of issue: June 17, 2012).

The researchers distributed and collected by hand a comprehensive data collection tool designed to investigate individual, organizational, physical, and psychological factors among the participants. The investigated factors are presented in detail in Box 1.

Box 1. Categorized Variables Based on Individual, Organizational, Physical, and Psychological Risk Factors

Factors
Individual factors
Dominant hand (right, left or both sides)
Marital status (single, married)
Employment status (permanent or conventional)
Cigarette smoking (yes, no)
Leisure time physical activity (yes, no)
Physical factors
Uncomfortable postures (sitting, standing, squatting)
Working hours with a computer
Organizational factors
Perceived needed changes to workstations by office workers' Chair
Keyboard or desk height
Distance to monitor
Access to an adjustable desk (yes, no)
Access to an adjustable footrest (yes, no)
Knowledge about ergonomics (yes, no)
Working hours with no rest break
Working years in current position
Total job experience (y)
Average number of working hours per week
Psychosocial factors
Job strain

The sections concerning individual, organizational, and physical data were developed based on the literature review. A pilot study was conducted to evaluate the validity and reliability of this part of the tool, and the researchers tried to ensure the questions asked were clear, readable, and essential. In order to assess its validity, the questionnaire was sent to ten professors of occupational medicine who then provided feedback. The content validity ratios (CVR) of the questionnaire constructs were 0.61 to 0.76, while the content validity index (CVI) structures were 0.76 to 0.84. The internal consistency/reliability of the questions as established with Cronbach's α was 0.85.

Psychosocial factors (i.e., job strain) were evaluated with the job content questionnaire (JCQ). The evaluation of psychosocial factors using the JCQ consisted of 27 questions that were based on Karasek's job demand-control model. The JCQ evaluated several subscales, including skill discretion, decision-making authority, job demands, coworker and supervisor support, and job insecurity (13). A four-point scale was used for all the subscales, with the ratings ranging from strongly disagree = 1 to strongly agree = 4. Job strain was calculated using the following equations, as recommended by Karasek et al. (13):

Skill discretion = (Q1 + Q3 + Q5 + Q7 + Q9 + 5 - Q2) × 2

Job decision-making authority = (2 ×(Q4 + Q6 + Q8)) × 2

Job decision latitude (control) = Skill discretion + Job decision-making authority

Job demands = 3 × (Q10 + Q11) + 2× (15- Q13 - Q14 - Q15)

Coworker Support = Q17 + Q18 + Q19 + Q20

Supervisor Support = Q21 + Q22 + Q23 + Q24

Job Insecurity = Q 25 + Q27 + 5-Q16

Job stress was defined as a score above the sample median on job demands

as well as below the sample median on job decision latitude.

In addition, for each subscale the score was dichotomized by a median cut-off point. The job demand-control model divides workers into high job strain (high

demand and low control), active job strain (high demand and control), passive job strain (low demand and control), and low job strain (low demand and high control). The respondents in the low, active, and passive job strain groups were categorized into a non-high strain group.

The Persian version of the questionnaire, which has been validated by Choobineh et al., was used in the present study. In their study, the Cronbach's alpha reliability coefficients for all of the subscales ranged between 0.64 and 0.85 (14).

Upper extremity MSDs (shoulders, elbow and hand/wrist disorders) during the past 12 months were measured by the general nordic musculoskeletal questionnaire (NMQ) (15). The validity and reliability of the NMQ have been investigated and approved in the Persian language (16).

3.1. Statistical Analysis

The total sample size was 1630, which was calculated based on the pilot study, considering that α = 0.05, β = 0.2. The Kolmogorov–Smirnov test for goodness of fit to a normal distribution was performed. At first, we used a descriptive and frequency analysis for the descriptive analysis of our variables. Student's t-test was used for the comparison of the means of the continuous variables between the two groups. The categorical variables were given as counts. The group comparisons were made using the chi-square test and goodness of fit. Then, we used binary logistic regression to identify the predictors of musculoskeletal disorders in the two different models. We included shoulder symptoms and hand/wrist symptoms in each model as dependent variables in order to determine which one of the independent variables may play a role as the predictor of symptoms in these regions. All calculations were performed using SPSS version 16 (SPSS Inc., Chicago, IL). A probability level (P value) of < 0.05 was considered to be statistically significant.

4. Results

Of the 1488 office workers who participated in the study, 1372 (92.2%) were men, 559 (37.6%) had a bachelor's degree, 1333 (89.6%) were married, and 1127 (75.8%) were permanently employed. The mean (SD) age and total number of years of job experience were 35.99 (7.68) and 12.33 (7.53), respectively, while the mean (SD) of work experience in current position was 6.2 (5.5) years. The participants worked for an average (SD) of 43.6 (9.5) hours per week. Some 396 (26.6%) participants worked with a computer for two or more hours per day. Up to 1263 (84.9%) of participants had experienced continuous work with no break for more than two hours. The majority of the study population were right-hand dominant (81.7%), while only 272 (18.3%) were left-hand dominant. Cigarette smoking and lack of leisure time physical activity were reported by 125 (8.4%) and 574 (38.6%) participants, respectively.

Assessing the features of workstations (categorized as organizational factors) showed that 330 (22.2%) participants perceived that their chair height needed to be adjusted. The desk or keyboard height in 293 (19.7%) cases was not suitable. The height of the monitor or its distance from the user was inappropriate for 253 (17.0%) participants. Some 406 (27.2%) participants' chairs were not appropriate and hence needed to be changed. In total, 595 (40.0%) participant office workers believed that they had sufficient knowledge regarding ergonomics in the workplace.

Overall, 412 (27.7%) participants reported upper extremity symptoms, including 269 (18.1%) in the shoulders, 79 (5.3%) in the elbows, and 207 (13.9%) in the hands/wrists. In addition, 295 (19.8%) participants complained of pain in one, 87(5.8%) in two, and 29 (1.9%) in three of the abovementioned body regions.

Based on the job demand-control model, job strain (categorized as psychological factors) in 416 (27.9%) of participants was classified as high, in 398 (26.7%) as passive, in 353 (23.7%) as active, and in 321 (21.5%) as low strain.

The univariate analysis explored how none of the individual factors were significantly related to shoulder, elbow, and hand/wrist MSDs (Table 1).

The association of physical and organizational factors with upper limb MSDs was evaluated. The total number of years of job experience was related to shoulder symptoms (P = 0.01). There was no association between MSDs and organizational factors such as number of working hours per week (P = 0.30 in shoulder, P = 0.99 in elbow, and P = 0.44 in hand/wrist), years of work in current position (P = 0.56 in shoulder, P = 0.22 in elbow, and P = 0.36 in hand/wrist), and total years of job experience (P = 0.06 in elbow and P = 0.44 in hand/wrist). Other physical and organizational factors related to shoulder, elbow, and hand/wrist MSDs are presented in Table 2.

Variables such as uncomfortable sitting posture, limited rest breaks, and no access to an adjustable desk accounted for 24.7% of the total variance in predicting shoulder MSDs. The R square of 0.17 suggested that variables including computer work for more than 5 hours, uncomfortable sitting posture, and unadjusted keyboard or desk height predict hand/wrist symptoms.

Elbow (P = 0.02) and hand/wrist symptoms (P = 0.02) were associated with job strain among the participant office workers. Most of the people with elbow and hand/wrist symptoms were suspected to be in the high strain category

Table 1. Individual Factors and Upper Extremity Msds During the Past 12 Months

	Shoulder Pain, No. (%)			Elbow Pain, No. (%)			Hand/Wrist Pain, No. (%)		
	Yes, N = 269	No, N = 1219	P	Yes, N = 79	No, N = 1409	P	Yes, N = 207	No, N = 1281	P
Married	249 (92.6)	1084 (88.9)	0.05	73 (92.4)	1260 (89.4)	0.36	180 (86.9)	1153 (90.0)	0.23
Permanent employed	226 (84.0)	901 (73.9)	0.13	68 (86.1)	1059 (75.2)	0.41	167 (80.7)	960 (74.9)	0.06
Cigarette smoking	24 (8.9)	101 (8.3)	0.90	9 (11.4)	116 (8.2)	0.40	22 (10.6)	103 (8.0)	0.34
Lack of physical activity	104 (38.7)	470 (38.5)	0.60	31 (39.2)	543 (38.5)	0.90	84 (40.6)	490 (38.2)	0.64
Right hand dominant	231 (85.9)	985 (81.0)	0.58	67 (84.8)	1149 (81.5)	0.77	174 (84.0)	1042 (81.3)	0.09

Table 2. Associations Between Physical and Organizational Factors and Upper Extremity Msds in the Past 12 Months

Risk Factors	Shoulder Pain, No. (%)			Elbow Pain, No. (%)			Hand/Wrist Pain, No. (%)		
	Yes, N = 269	No, N = 1219	P	Yes, N = 79	No, N = 1409	P	Yes, N = 207	No, N = 1281	P
Physical									
Working hours with computer			0.21			0.98			0.001
< 30 minutes	105 (39.0)	459 (37.7)		31 (39.2)	533 (37.8)		74 (35.7)	490 (38.3)	
30 - 60 minutes	32 (11.9)	132 (10.8)		9 (11.4)	155 (11.0)		21 (10.1)	143 (11.2)	
1 - 2 hours	37 (13.8)	202 (16.6)		13 (16.5)	227 (16.1)		28 (13.5)	212 (16.5)	
2 - 5 hours	39 (14.5)	129 (10.6)		9 (11.4)	159 (11.3)		26 (12.6)	142 (11.1)	
> 5 hours	49 (18.2)	164 (13.5)		14 (17.7)	199 (14.1)		51 (24.6)	162 (12.6)	
Uncomfortable posture in			0.01			0.57			< 0.001
Sitting	56 (20.8)	189 (15.5)		18 (22.8)	227 (16.1)		52 (25.1)	193 (15.1)	
Standing	45 (16.7)	227 (18.6)		14 (17.7)	258 (18.3)		43 (20.8)	229 (17.9)	
Squatting	90 (33.5)	322 (26.4)		23 (29.1)	389 (27.6)		64 (30.9)	348 (27.2)	
Organizational									
Working hours with no rest break			0.01			0.41			0.13
1 - 2 hours	31 (11.5)	194 (15.9)		11 (13.9)	214 (15.2)		27 (13.0)	198 (15.5)	
2 - 5 hours	84 (31.2)	389 (33.0)		23 (29.1)	451 (32.0)		61 (29.5)	413 (32.2)	
5 - 8 hours	110 (40.9)	399 (32.7)		29 (36.7)	480 (34.1)		84 (40.6)	425 (33.2)	
>s 8 hours	34 (12.6)	94 (7.7)		11 (13.9)	117 (8.3)		24 (11.6)	104 (8.1)	
Not suitable and need to adjust/change									
Chair height	70 (26.0)	256 (21.0)	0.21	21 (26.6)	305 (21.6)	0.4	50 (24.2)	276 (21.5)	0.71
Keyboard or desk height	68 (25.3)	220 (18.0)	0.03	24 (30.4)	264 (18.8)	0.02	56 (27.1)	232 (18.1)	0.01
Distance to monitor	54 (20.1)	197 (16.2)	0.28	20 (25.3)	231 (16.4)	0.07	40 (19.3)	211 (16.5)	0.53
Chair	77 (28.6)	327 (26.8)	0.99	24 (30.4)	380 (27.0)	0.73	55 (26.6)	349 (27.2)	0.47
Access to adjustable desk	51 (19.0)	299 (24.5)	0.01	19 (24.1)	331 (23.5)	0.87	43 (20.8)	307 (24.0)	0.1
Access to adjustable footrest	119 (44.2)	504 (41.3)	0.98	38 (48.1)	585 (41.5)	0.41	90 (43.5)	533 (41.6)	0.77
Knowledge regarding ergonomics	115 (42.8)	496 (40.7)	0.91	38 (48.1)	573 (40.7)	0.36	93 (44.9)	518 (40.4)	0.59

(40.5% and 37.2%, respectively) and less of them were active (10.1% and 16.9%, respectively) (Table 3).

Table 4 provides the results of the binary logistic regression analyses, which explored the associations between the main investigated risk factors and upper extremity MSDs in the past 12 months. With regard to shoulder symptoms, our analysis showed a higher risk in participants who complained of their sitting posture (β = 0.42, P = 0.040), continuous work with limited rest breaks (β = 0.23, P = 0.005), and having no access to an adjustable desk (β = 0.43, P = 0.018). None of the studied variables could predict elbow symptoms. Computer work for more than 5 hours (β = 0.61, P = 0.004) and an uncomfortable sitting posture (β = 0.79, P = 0.001) predicted hand/wrist MSDs.

5. Discussion

The analysis of the collected data attributed to the individual, physical, organizational, and psychological factors showed that various factors were correlated with shoulder, elbow, and hand/wrist MSDs during the last 12 months. In line with our study, previous research efforts have revealed that the risk factors of MSDs in different upper extremities are not the same (9).

Table 3. Psychological Factors (i.e., Job Strain) in Office Workers with Upper Extremity Msds in the Past 12 Months

Psychological Factor	Shoulder Pain, No. (%)			Elbow Pain, No. (%)			Hand/Wrist Pain, No. (%)		
	Yes, N = 269	No, N = 1219	P	Yes, N = 79	No, N = 1409	P	Yes, N = 207	No, N = 1281	P
Job Strain			0.1			0.02			0.02
High strain	86 (31.9)	330 (27.1)		32 (40.5)	384 (27.3)		77 (37.2)	339 (26.5)	
Active	69 (25.7)	284 (23.2)		8 (10.1)	345 (24.5)		35 (16.9)	318 (24.9)	
Low strain	44 (16.4)	277 (22.7)		21 (26.6)	300 (21.3)		45 (21.7)	276 (21.5)	
Passive	71 (26.4)	327 (26.8)		18 (22.8)	380 (26.9)		51 (24.7)	378 (27.0)	

Table 4. Binary Logistic Regression Analysis of Risk Factors Associated with Upper Extremity Msds During the Past 12 Months

Region	Risk Factor[a]	Beta	S.E	P Value	Exp (B)	95% C.I for Exp (B)	
						Lower	Upper
Shoulder							
	Uncomfortable posture (sitting)	0.42	0.21	0.040	1.53	1.02	2.30
	Working hours with no rest break (> 8 hours)	0.73	0.29	0.012	2.08	1.17	3.68
	Access to adjustable desk (no)	0.43	0.18	0.018	1.54	1.07	2.19
Hand/Wrist							
	Working hours with computer(>5 hours)	0.61	0.21	0.004	1.8	1.20	2.80
	Uncomfortable posture (sitting)	0.79	0.24	0.001	2.2	1.4	3.5

[a] Reference category is in parentheses.

In our study, the prevalence of musculoskeletal symptoms in more than one region was less than that found in a related study (11). Participants' knowledge about ergonomic principles was not related to any of the studied upper extremity MSDs. Previous studies have reported contradictory results in this regard. For instance, some have suggested that office ergonomic training was effective in reducing musculoskeletal pain/discomfort (17), while others showed that training alone cannot decrease MSDs (18). We believe that training may increase office workers' knowledge regarding ergonomic principles, although this knowledge is not sufficient as employees also need opportunities to access and use appropriate office equipment.

5.1. Shoulder

In the present study, none of the studied individual factors were related to shoulder MSDs in the last 12 months. The findings concerning the relationship between the studied individual factors and upper extremity disorders in previous research studies have not been consistent. In line with our study, some studies have not found any relationship between the development and persistence of MSD symptoms and smoking (19), leisure time physical activity (20), marital status (21), and dominant hand (22). However, in contrast to the present study, other prior studies did find associations between MSDs and smoking (23, 24), leisure time physical activity (25), marital status (26), and dominant hand (27). The fact is that individual factors such as those investigated in this study are affected by various factors in different individuals, communities, and occupations. Therefore, previous studies could not easily indicate their causal relationship with MSDs, especially with shoulder disorders.

The results of the study revealed that the risk of experiencing shoulder symptoms was higher among office workers who reported discomfort in relation to their sitting posture. Janwantanakul et al. (1) and Hamberg-van Reenen et al. (28) also introduced positional discomfort as a potential predictor of neck and shoulder disorders among workers. Musculoskeletal symptoms caused by posture-related discomfort may be the result of an overuse of low threshold muscle fibers, which in turn affect muscle loading, exert compressive forces, and therefore cause trauma in the muscle cells (29).

In this study, job strain did not predict shoulder symptoms. Only a limited number of Iranian studies have examined the associations between psychosocial factors and the occurrence of upper extremity musculoskeletal pain (30, 31), and none of them concerned office workers. Our findings were in line with the first one and in contrast with the second. Part of this controversy may be attributed to the various work environments, social cultures, and different

study groups as well as differences in the job characteristics and job descriptions of the studied population in the present study and that in earlier surveys.

In this study, the protective effects of rest breaks and access to an adjustable desk on shoulder complaints were observed. Ortiz-Hernández et al. (32) and d'Errico et al. (11) confirmed our findings. A possible explanation for the supportive role of rest breaks in MSDs is that short breaks may help to prevent or alleviate muscle damage from overuse (33). However, a rest break can include the performance of another task, which of course involves the use of other muscle groups.

5.2. Elbow

None of the studied variables were related to elbow disorders. One possible explanation for our findings is an insufficient number of office workers suffering from elbow problems. In the study by Choobineh et al. (34), the prevalence of elbow MSDs among Iranian office workers was also low. Therefore, the findings should be considered with great caution.

5.3. Hand/Wrist

Working on a computer for more than five hours was associated with hand/wrist disorders. Several previous studies reported a positive association between the duration of computer use and hand/wrist symptoms (32). However, the harmful duration of computer use specified in different studies is not identical. In the literature, different criteria such as computer use for more than four hours per day (35), 15 hours a week (36), or more than 75% of work time (37) were defined as hazardous amounts of computer work. Therefore, further research is required regarding the time period that might contribute to upper extremity MSDs.

Based on the above results, an uncomfortable sitting posture and working on a computer for more than five hours were predictive variables of hand/wrist MSDs. Previous research has shown a good agreement between hand/wrist MSDs and working in an uncomfortable posture.

There are a number of weak and strong points in this study that need to be taken into account. The weak points can be summarized as follows. First, the cross-sectional design of the study resulted in the identification of a number of associations between variables, although it was not possible to determine the causal relationships. Second, the data collection was performed by means of participants' self-reporting due to resource constraints; therefore, the accuracy of the collected data may be compromised. Self-reported data may also increase recall bias. In addition, self-reporting may cause workers with MSDs to be compared to people without disorders who overestimate their symptoms. Hence, further interventional studies are suggested. Third, the study population was limited to office workers, so the results could not be generalized to other workers. On the other hand, collecting musculoskeletal health information from office workers in a province with no precise and up-to-date data, the relatively large sample size (1488 office workers), and the high survey response rate (91.3%) were among the strong points of this study.

In conclusion, upper extremity MSDs are linked to different individual, organizational, physical, and psychological factors. We found that various risk factors lead to musculoskeletal symptoms in different upper body areas. The predictors of shoulder symptoms consist of an uncomfortable sitting posture, limited rest breaks during working hours, and no access to an adjustable desk. We could not find any variables that predict elbow disorders. In addition, working on a computer for more than five hours and an uncomfortable sitting posture were associated with hand/wrist symptoms. Various risk factors predicted shoulder, elbow, and hand/wrist disorders. Therefore, any comprehensive workplace intervention aimed at preventing or reducing MSDs among Iranian office workers should concentrate on ergonomic and office equipment modifications, stress management programs, monitoring MSD symptoms through periodic screening examinations, and developing guidelines regarding adjusting workstations and preventive medical recommendations.

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Footnotes

Authors' Contribution: Seyed Shohreh Alavi served as the main investigator, performed the literature review, managed the study, and contributed to writing the paper. Mahya Abbasi managed the acquisition of data and contributed to the study design and writing the first draft. Ramin Mehrdad contributed to the analysis and interpretation of data.

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