

Original Article

Ergonomic Assessment of Exposure to Musculoskeletal Disorders Risk Factors among Dentists of Shiraz, Iran

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KEY WORDS

Musculoskeletal Disorders;
Dentistry;
Risk Assessment;

ABSTRACT

Statement of the Problem: In dental profession, exposure to risk factors of musculoskeletal disorders raises the probability of musculoskeletal injuries in different parts of the body.

Purpose: This study aimed to determine the prevalence of musculoskeletal disorders (MSDs), assess the risk of MSDs, and determine the risk factors of musculoskeletal injuries among dentists of Shiraz city.

Materials and Method: In this cross-sectional study, 136 dentists of Shiraz city were randomly selected. The data were collected by Nordic musculoskeletal questionnaire (NMQ). Ergonomic assessment of exposure to MSDs risk factors was carried out by assessment of repetitive tasks (ART) technique. In order to assess dentists' exposure to MSDS risk factors, the method of ART (ART) was adopted. This method has been designed to assess the risk of those tasks that required repetitive motion of upper limb, especially hands and arms. The collected data were analyzed through SPSS software (version. 22). The study regarded p value of <0.05 as significance level.

Results: Mean age of the participants was 35.6 ± 8.7 years. The 12-month prevalence of MSDs among dentists was 91.9%. The results suggested that risk of MSDs among dentists was high. The results of logistic regression analyses indicated that female gender ($p < 0.001$) and exercise for less than 3 hours per week ($p = 0.001$) played significant roles in occurrence of MSDs among the study population. Additionally, the results of ART assessment revealed that risk of MSDs in the right side of the subjects' bodies was higher.

Conclusion: The findings showed that risk of MSDs and their prevalence in the study population was high with significant association. Based on the results of regression modeling, it seems necessary to pay proper attention to factors associated with MSDs to develop ergonomic solutions to reduce or eliminate musculoskeletal injuries.

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Introduction

Work-related musculoskeletal disorders (WMSDs) are a major cause of lost working days and high cost of labor force injuries. These disorders are one of the biggest

occupational health challenges which industrial countries face and constitute one of the major problems that ergonomists from all over the globe endeavor to address. [1] Previous studies suggest that discomfort of

different parts of musculoskeletal system is a major problem that workers experience in their workplaces. As a result, one of the main reasons of work absenteeism is noted to be MSDs. Nowadays; many countries consider WMSDs prevention as a national necessity and priority. [2-13]

Musculoskeletal disorders refer to injuries of muscles, tendons, ligaments, joints, nerves, blood vessels, and all supportive structures that play a role in movement. The roles of ergonomic risk factors such as improper static postures, repetitive movements, force exertions, vibration, and biomechanical pressures in such injuries have been already noted. [14]

In dental profession, because of repetitive movements, long-term work in awkward static postures, exertion of high force and improper tools the probability of musculoskeletal injuries of different parts of the body is high. In the literature, the prevalence of dentists' discomforts in back, neck, shoulders, and hands as suggested in many studies conducted around the world ranges from 63 to 93%. [15]

Because of distinct characteristics of dental profession such as use of precise tools in a limited space, necessity of doing delicate manual tasks and staying in awkward postures for long time, the probability of musculoskeletal injuries is high. [16] Previous studies on dental profession suggest that dentists are exposed to risks of MSDs risks more than other medical professionals are. These injuries impose significant costs on dentists and affect adversely their quality of work, job performance, and efficiency. Therefore, identifying ergonomic factors present in dental workplace is of high importance. [1-2]

Given the above, the present study aimed to determine the prevalence of MSDs, assess exposure to MSDs risk factors among dentists of Shiraz City, and determine the risk factors associated with musculoskeletal injuries. The obtained results could be used to develop ergonomic interventional programs for prevention of MSDs and improving dentists' working conditions.

Materials and Method

In this cross-sectional study, 136 randomly selected dentists working in public or private dental clinics of Shiraz city participated. The inclusion criteria were minimum 1-year work experience and lack of history of

musculoskeletal injuries. Those dentists whose disorders were caused by non-occupational activities such as accident and leisure time activities were excluded from the study. The required data were collected via questionnaires. The questionnaires were filled out at dentists' workplaces through interviewing process. The questionnaire of personal and occupational characteristics included certain items on age, height, weight, marital status, and rest time between patients' visits. In order to determine prevalence of musculoskeletal symptoms in different body regions for the past 12 months, Nordic musculoskeletal disorders questionnaire (NMQ) was used. The reliability of the Persian version of the NMQ had already been addressed. [17-18] In this study, symptoms of MSDs refer to discomfort, pain, fatigue, swelling, stiffness, sensory impairment, limitation in joints range of motion, and reduced motion control of different parts of the body including neck, shoulders, wrists, back, waist and ankles.

In order to assess dentists' exposure to MSDS risk factors, the method of assessment of repetitive tasks (ART) was adopted. This method has been designed to assess the risk of those tasks, which require repetitive motion of upper limb, especially hands and arms. [19] Adopting ART method, assessment was carried out in four steps including (A)determining number of motions of hands and arms, (B) determining level of force exertion (i.e., low, medium, high, and very high force), (C)determining subjects' postures while doing their routine activities, and (D)determining other factors (i.e., rest time, working pace, duration of activities, and psychosocial factors). In the end, the sum of scores of each exposure was used to determine score of each task and total score of exposure. [20] The exposure score is interpreted based on Table 1.

In the present study, the selected dental clinics were visited and awkward and repetitive dentists work-

Table 1: Determination of exposure level based on exposure score through ART method

Exposure Score	Exposure Level	Recommendation
0-11	Low	Take personal conditions into account
12-21	Medium	More examination is necessary.
22 or higher	High	More immediate examination is necessary.

Table 2: Shows an illustrative worksheet for assessing the risk factors in dentists' workplace by ART method

Name of Unit:	Observer:	Measurement Date:	Measurement Time:
01-Left Hand			
Duty: Dentistry			
Assessment Factors	Left Color	Side Score	Right Color Side Score
A1 Arm Movement		3	0
A2 Repetition (Movement of Hands and Arms)		0	0
B Force		4	2
C1 Head and Shoulders		3	2
C2 Back (Waist)		3	2
C3 Arms		4	0
C4 Wrists		2	1
C5 Hands and Fingers		2	0
D1 Restless Working		2	0
D2 Speed of Working		1	0
D3 Other Factors		2	1
Total Job Score		44	8
D4 Duration Coefficient		1x	1x
Exposure Score		24	8
D5 Psychosocial Factors	High Level	Of Attention	and Concentration
Determination of	Exposure	Level Based	On Exposure Score
Exposure Score		Suggested	Exposure Level
0-11	Low		Take personal conditions into account
12-21	Medium		Further examination is required.
22≥	High		Further immediate examination is required.

ing postures were photographed for further review. In order to determine risk level of MSDs, specific scoring worksheet (Table 2) was filled out for each workplace (i.e., station) and risk level of MSDs for each station was determined. Based on ART method, risk levels were classified into three groups including green color (low risk), yellow color (medium risk), and red color (high risk). [19]

Data analysis was conducted through SPSS Software (version 24) and level of significance (P) was set at less than 0.05. The association between qualitative variables and MSDs was analyzed through Chi-square test. Determination of risk factors associated with MSDs was done through forward LR logistic regression modeling. In regression analysis, if the *p* value of Chi-square test for assessing association between the variables and reported symptoms was equal to or less than 0.25, the variable was included in the regression model. For each body region, this procedure was performed. [24]

Results

In this study, 136 dentists working in public and private clinics were examined. Some demographic characteristics of the subjects are detailed in Tables 3 and 4.

Observably, mean age and weight of the participa-

Table 3: Demographic and occupational characteristics of the dentists studied (n=136)

Variable	Mean	SD	Range
Age (year)	35.6	8.7	23-64
Weight (kg)	68.3	12.3	44-103
Height (cm)	168.2	9.1	145-190
Number of Children	0.7	0.8	0-3
Between-visit Rest Time (min)	6	2.4	5-15

nts were 35.6±8.7 years and 68.3± 12.3kg, respectively. Most of the participants were female (55.9%) and married (74.3%). In terms of working hours per day, the highest frequency was related to 8 hours/day (74.3%). Based on our observations, the dentists worked in sedentary posture (92.6%). Almost half of the participants (i.e., 51.5%) reported that they exercised regularly. In this study, exercise refers to regular exercise for half an hour per day such as walking or other physical trainings. Regarding to the number of children, the highest frequency (52.2%) was related to those participants with no child. In this study, the term “rest time” between patients meant the duration that dentists rested after visiting a patient and before starting visiting the next one. The results showed that most dentists spent five minutes resting between visits. In addition, most dentists (95.6%) were right-handed.

The results of NMQ are represented in Table 5. In general, 91.9% of the dentists had experienced sympto-

Table 4: Demographic and occupational characteristics of the participants (n=136)

Characteristics	Percentage	Musculoskeletal Disorders		p Value*
		No (n=11) Frequency (Percentage)	Yes (n=15) Frequency (Percentage)	
Gender	Male	55.9	11 (100)	<0.0001*
	Female	44.1	0(0)	
Marital Status	Married	25.7	8 (72.7)	0.9
	Single	74.3	3 (27.3)	
Level of Expertise	General	75.7	7 (63.6)	0.33
	Specialized	24.3	4 (36.4)	
Out-of-Clinic Activity	Yes	24.3	8(72.7)	0.81
	No	75.7	3(27.3)	
Exercise	Yes	74.3	11 (100)	0.001*
	No	25.7	0(0)	
Duration of Working	<8	92.6	6 (54.6)	0.12
	≥8	7.4	5 (45.5)	
Type of Activity	Sedentary	51.5	11(100)	0.33
	Standing and Sedentary	48.5	0(0)	
Number of Children	No Child	52.2	7 (63.6)	0.43
	More than One Child	30.1	4(36.4)	

Note: * Chi-square Test.

Table 5: Prevalence of MSDs in the past 12 months among the study population (n=136)

Body Part	N (%)	95% Confidence Interval
Neck	51(37.5%)	33.3-41.7
Shoulder	35(25.7%)	33.0-18.4
Elbow	68(50%)	41.6-58.4
Wrist	92(67.6%)	59.7-75.5
Upper Back	84(61.6%)	52.6-69.9
Lower back	48(35.3%)	27.3-43.3
Hips and Thighs	31(22.8%)	15.8-29.9
Knee	40(29.4%)	21.7-37.1
Ankle	29(21.3%)	14.4-28.2

ms in at least one region of their body within the last 12 months. Prevalence of symptoms in participants' wrist, upper back, neck, and lower back were 67.6%, 61.8%, 37.5%, and 35.3% respectively. The lowest reported problem was related to ankle (21.3%).

Table 6 represents risk levels of MSDs determined through ART method for left and right sides of the participants' bodies. As shown in this table, mean total score of risk for right and left sides were 35.0±4.02 and 12.40±4.02, respectively. The results of Wilcoxon test suggested that scores of risk for right and left sides were significantly different ($p \leq 0.001$) in the sense that right body side had higher risk exposure. In addition, most of dentists' postures were classified in high priority for corrective actions. This meant that dentists' working postures required modification and ergonomic interventions. Figure 1 shows an illustrative worksheet for assessing the risk factors in dentists' workplace by ART method as well as common working posture that dentis-



Figure 1: Working posture of dentist

ts adopted. The regression analysis for determination of factors contributing to MSDs is displayed in Table 7. As mentioned before, in order to examine the effect of demographic and occupational factors on prevalence of MSDs, stepwise regression modeling was conducted. The modeling results suggested that the variables of gender and exercise were significantly associated with such disorders ($p < 0.01$) and probabilities of MSDs in neck, shoulder, right wrist, upper back, lower back and wrist were higher among females than males. In addition, probability of musculoskeletal disorders in right shoulder, right wrist, hips and thighs and knees of those who did not have any exercise in their daily program was higher than those who had.

Discussion

Determination of MSDs prevalence in the target popula-

Table 6: Assessment of dentists' exposure based on exposure scores of left and right body sides (n=136)

Risk Level	Right Frequency	Side Percentage	Left Frequency	Side Percentage	Recommendation
Low	4	2.94	61	44.8	Take personal conditions into account
Medium	15	11.02	68	50	Further examination is required.
High	117	86.02	7	5.14	Further immediate examination is required.

tion is the first step to prevent this sort of problems. Based on the study protocol, none of the dentists had past history of any disease affecting their musculoskeletal system. The high frequency of such disorders (91.9%) among dentists when taking participants' mean age and other characteristics into consideration necessitates ergonomically appropriate intervention plans for this occupational group. The prevalence of MSDs among dentists was high which was in line with the findings of Hayes *et al.* [20] and Dougherty. [21] The highest prevalence rates were reported for wrist (67.6%), upper back (63.2%), and elbow (50%). Valachi [22] similarly pointed out that these body parts had the highest prevalence of symptoms among dentists. Choobineh *et al.* [23], Ardakani *et al.* [24], Ahmadi *et al.* [25], and Nasl Seraji *et al.* [26] indicated that wrist injuries were a common musculoskeletal problem among dentists. However, in other studies, the neck, shoulders, and back were reported as the body parts characterized with high prevalence of MSDs. [27-33]

In study Munabi *et al.* [34] in Uganda and Josephson *et al.* [35] in Sweden and smith *et al.* [36] in Japan and smith *et al.* [37] in China and Taghinejad *et al.* [38] in Iran, the prevalence of musculoskeletal disorders among nurses was high and similar to the results of this study. Vieira *et al.* [39] reported the prevalence of MSDs among high doctors. Joshi *et al.* [40] and

Sarsangi *et al.* [41] reported high MSDs among workers.

To do their occupational activities, dentists use their hands more frequently than other professions. In fact, dentists' wrists exerted repetitive high forces. This could contribute to injure this body region. Doing sedentary tasks consistently and for a long time while taking improper postures could also contribute to injuries of dentists' back.

The results of risk factors assessment of dentists' workplace through ART method demonstrated that 86.02% of the dentists were exposed to high-risk level in their right body side. Therefore, further examination of the dentists' workplaces seemed essential to correct their working conditions. It is to be noted that highest risk exposure for dentists' left body side was medium (about 50%). Sohrabi *et al.* [42], Abbaszadeh *et al.* [43], and Jafari Rodbandi *et al.* [44] drew similar conclusions and pointed to necessity of improving the working conditions due to dentists' high-risk level exposure.

Personal characteristics were among significant variables associated with MSDs. The findings of the present study through logistic regression analysis indicated that gender was a risk factor affecting all body parts except for wrists, elbows, hips, and thighs.

Based on the odds ratios of all body parts (all>1), one could conclude that likelihood of MSDs in women

Table 7: Models indicating factors with association with MSDs symptoms in different body regions of the participants (n=136)

Body region	Risk Factor	OR*	95% CI†	p Value
Neck	Gender-Female	18.1	6.5-50.2	<0.0001
	Less than 3 hours exercise per week	9.3	3.3-26.1	<0.0001
Shoulders	Gender-Female	5.5	2.4-12.7	<0.0001
	Less than 3 hours exercise per week	7.8	3.3-18.7	<0.0001
Elbow	Less than 3 hours exercise per week	14.9	6.5-34.4	<0.0001
Wrist	Gender-Female	28.8	8.7-95.6	<0.0001
	Less than 3 hours exercise per week	22.8	6.5-79.6	<0.0001
Upper back	Gender-Female	7.6	3.1-18.6	<0.0001
	Less than 3 hours exercise per week	9.7	3.8-24.6	<0.0001
Lower back	Gender-Female	4.4	1.8-10.7	<0.0001
	Less than 3 hours exercise per week	10.9	4.1-29.3	<0.0001
Hips and Thighs	Less than 3 hours exercise per week	2.8	1.2-6.5	0.02
Knees	Less than 3 hours exercise per week	4.2	1.9-9.4	<0.0001
Ankle	Gender-Female	1.4	0.2-1.9	0.03
	Less than 3 hours exercise per week	3.6	1.4-8.9	0.006

Notes: * odd ratio, † confidence interval

was more than that in men. This result was supported by the findings of Nasl Seraji *et al.* [26] and Alghadir *et al.* [45] studies.

The results of regression modeling showed that the variables of female gender and exercise for less than 3 hours per week were risk factors associated with neck, shoulder, wrist, upper back, lower back, and ankle. In addition, lack of exercise was identified as a risk factor for all body parts. Based on odd ratios obtained for all body parts, one could conclude that probability of MSDs among dentists lacking exercise was higher than those who had exercise.

Conclusion

The assessment of risk of MSDs and prevalence of musculoskeletal disorders among dentists revealed that prevalence and risk of such injuries were high. The analysis of personal risk factors through regression analysis indicated that female gender and exercise for less than 3 hours per week were influential upon musculoskeletal disorders of most body parts. In addition, the results of posture analysis suggested that risk of symptoms occurrence in right side of dentists' bodies was high. Therefore, to minimize musculoskeletal symptoms among dentists, it is necessary to consider these risk factors and to develop ergonomic solutions through interventional programs and working conditions improvement.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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