# Assessment of Individual and Occupational Risk Factors of Musculoskeletal Disorders Using BPAI among Dentists in Qom, Iran

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**Background & Aims of the Study:** Improper posture of dentists causes cumulative pressure on their body and ultimately leads to occupational injuries. Despite the existence of numerous studies performed on musculoskeletal pain, complaints around this disease are still widespread in the dentistry profession. This study was aimed at the precise identification of individual and occupational risk factors for musculoskeletal pain among dentists working in Qom, Iran, in 2018.

**Materials and Methods:** This cross-sectional study was conducted on 51 dentists with at least one year of work experience. In this study, the occupational sitting activities were taken into account. In order to evaluate the ergonomics status of such activities, Branson's Posture Assessment Instrument (BPAI) was used. The data were collected using a researcher-made demographic form and body map questionnaire. Statistical analysis of data was performed in SPSS software (Version 22) by Mann-Whitney U test, Kruskal-Wallis H test, and Spearman's correlation coefficient.

**Results:** Based on the results of the study, 84.3% (n=43) of the dentists had pain in at least one or more parts of their musculoskeletal system. The most commonly affected areas were the neck (72.7%) and shoulder (54.5%). In addition, 21.6% and 80.4% of postures were at acceptable and compromised levels, respectively. It was revealed that posture had a significant relationship with work experience and the amount of rest breaks (P<0.05). Based on the results of Spearman's correlation coefficient, the final BPAI score showed a significant relationship with the amount of rest breaks , number of training courses, and work experience (P<0.05).

**Conclusion:** Despite the implementation of preventive measures and utilization of new tool and equipment design processes, ergonomic disorders are prevalent in dental profession. Therefore, it is required to make reforms at various physical and systemic levels to improve the situation.

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# Background

Musculoskeletal disorders are among the

major problems threatening workers' health conditions in developed and developing countries. These disorders are also considered to be responsible for more than 60% of all

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occupational injuries (1). This type of injury occurs when the body loses the ability to compensate for the long-term stress caused by repetitive movements in inappropriate postures (2). Although there have been considerable developments in occupational risk management, musculoskeletal disorders are still among the main risk factors in the workplace (3).

Dentists are considered the professionals highly vulnerable to ergonomic injuries due to the type of services they provide, compared to other healthcare providers (1, 4). Dentistry, due to its specific job characteristics, requires high accuracy and concentration (5) and is inherently stressful (6). In addition, this job entails prolonged static postures (7). Considering the fact that dentists have to work on a small and limited area (i.e., the mouth), they have no choice other than adopting inappropriate, asymmetrical, and at the same time static postures during working (8, 9).

It is estimated that a dentist spends approximately 60,000 h of their work life in an inappropriate ergonomic posture. Accordingly, the pain caused by ergonomic injuries has become one of the common complaints among dentists recently (10, 11). The severity of the injuries caused by improper postures is to the extent that it has turned musculoskeletal disorders to the most important reason for early retirement among dentists (12).

The results of various studies conducted in different countries report a high prevalence of musculoskeletal disorder symptoms among dentists, with the neck, shoulders, back, and lower back as the most commonly affected areas (1, 13-16). The prevalence of these disorders has been reported to be between 63% and 93% in the waist, neck, shoulder, and hand (17-23). Based on the statistics, the prevalence of pain in Iranian dentists is significant in the neck, wrist, waist, and shoulder (24-24).

Dentists spend about 80% of their work time in a sitting position with 45% of this period in a 30-degree rotation of the trunk. Moreover, their neck is in a 60-degree working position in 50% of these cases, while their arms are at the angles of 30-90 degrees away from the trunk. It has been found out working while standing follows the same pattern to a large extent (27). Musculoskeletal pain influences the performance of dentists in various ways, such as limiting the number of patients visited daily, reducing the control and skills in performing delicate tasks, and affecting the dentist-patient relationship (28, 29).

Different methods have been applied to investigate musculoskeletal disorders in this profession (30). However, in recent years, observational methods and direct measurements have gained wider applications for posture assessment since their validation process is not as complex and difficult as that of self-report methods, which are highly dependent on individuals' opinions (31).

Although in numerous studies, general tools, such as the Rapid Upper Limb Assessment, have been adopted to assess ergonomic posture (16, 35-32), they cannot provide an accurate understanding of the effects of body posture on the musculoskeletal system unless being specifically designed for a job (36). In this regard, Branson et al. designed and validated such a tool for assessing the physical condition of dentists in 2002 (2). To the best of our knowledge, no specific research has utilized this instrument on Iranian dentists.

Based on the findings of previous studies, ergonomic disorders are highly prevalent in Iran (8, 37). Moreover, psychosocial variables (e.g., stress) (7, 13), tools (38), and even economic and welfare conditions of communities (39) have been proven to be influential in the incidence of musculoskeletal disorders. Accordingly, this study was conducted to evaluate the individual and occupational risk factors for musculoskeletal disorders among dentists in Qom, Iran.

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### **Materials & Methods**

This cross-sectional study was performed on 51 dentists with at least one year of work experience, in Qom in 2018. It should be noted that these cases had to carry out tasks in standing and mostly sitting positions. The participants were entered into the study using the availability sampling technique. However, they were informed about the possibility of study withdrawal at any research stage. In this research, the tasks performed in sitting positions were taken into account.

The Branson's Posture Assessment Instrument (BPAI), as a pen-and-paper-based observational method, was utilized to evaluate occupational ergonomics. At the first stage, several photos were captured from employees' work cycles, which were then reviewed. Afterward, the most frequent or prolonged movements in the work cycles were selected to be evaluated by means of this instrument. The scoring of the physical condition of the cases was accomplished using a scoring guide.

A demographic form was distributed among the dentists to collect such information as age, gender, education level, work experience, stress, average time spent per patient, and marital status. Another instrument used in this study was the body map questionnaire that divides the human body into anatomical areas. The main aim of this questionnaire is to find out the parts of the body mostly affected by musculoskeletal disorders.

The obtained data were analyzed in SPSS software (version 22). Given the non-normality of data distribution as revealed by Kolmogorov-Smirnov test, the data were analyzed using Mann-Whitney U test, Kruskal-Wallis H test, and Spearman's correlation coefficient. Any participation in this study was completely voluntary, and the subjects could leave the study at any stage without subsequent problems or consequences.

#### **Branson's Posture Assessment Instrument**

This tool was developed and validated by Branson et al. in 2002 to evaluate the posture of individuals involved in dentistry, especially dentists (2). Each activity in five regions of namely thighs, waist, head and neck, shoulders, and wrist, was recorded for 5 min and evaluated subsequently. The physical conditions in the mentioned regions were analyzed in the 1<sup>st</sup>, 3<sup>rd</sup>, and 5<sup>th</sup> min, and the total score was then calculated. Finally, the scores of these five categories were added up to obtain the total score. Table 1 presents the worksheet applied in this method, as well as the scoring system adopted to score body postures in each of the five body parts.

This instrument has a score range of 10-194 with the lowest score representing the most favorable condition. Based on the scores, the posture of participants was classified as acceptable, compromised, and harmful. These classifications can be interpreted as follows:

Acceptable (10-40): postures in this classification will not expose the dentist at the risk of musculoskeletal or cumulative trauma disorders.

Compromised (41–80): postures in this classification, in case of being repeated for more than 5 min throughout the workday, will expose the dentist at the risk of musculoskeletal or cumulative trauma disorders.

Harmful (81–194): posture in this classification, repeated at any length of time, will expose the dentist at the risk of musculoskeletal or cumulative trauma disorders.

#### **Results**

This study involved 42 male and 9 female dentists whose demographic information is provided in Table 2. Considering the handedness of the subjects, 88%, 10%, and 2%

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		Time				
Acceptable	Compromised	Compromised Harmful		3 min	5 min	Total
1 point	2 points	2 points 3 points				
		Hips				
Level on stool	Hips not level on stool					
		Trunk				
Front to back $<20^{\circ}$	Front to back $>20^\circ < 45^\circ$	Front to back $>45^{\circ}$				
Side to side $< 20^{\circ}$	Side to side $>20^\circ$ , $<45^\circ$	Side to side $>45^\circ$				
Rotation between planes	Rotation between planes	Rotation between planes				
<20°	$>20^{\circ} < 45^{\circ}$	>45°				
	/20, (15	_10				
	Не	ead / Neck				
Front to back $\leq 20^{\circ}$	Front to back $>20^\circ$ , $<45^\circ$	Front to back $\geq 45^{\circ}$				
Side to side $\leq 20^{\circ}$	Side to side $>20^\circ$ , $<45^\circ$	Side to side $\geq 45^{\circ}$				
Rotation between planes	Rotation between planes	Rotation between planes				
≤20°	>20°, <45°	≥45°				
	S	houlders				
Relaxed	Slumped forward	nounders				
Both shoulder level with	One or both shoulder					
trunk	elevated above line of trunk					
		Wrist				
Flexion or extention $\leq 15^{\circ}$	Flexion or extension>15°					
(either wrist)	(either wrist)					
	To	otal Points				
	Table 2) Demographic chara	cteristics of study population	on (n=51	)		
Demographic Cha	racteristics Me	an Standard devia	tion	Minimur	n Ma	ximum
Age	40.0	9.53		25		64
Work experienc	<b>re (years)</b> 13.	37 8.93	3 1			41
Work hours (	weeks) 45.	89 20.87		6		100

4.45

6.18

Table 1) Branson's posture assessment instrument worksheet

of them were right-handed, left-handed, and mixed-handed, respectively.

Stress Breaks during work (minutes)

Based on the self-report demographic forms, almost all of the subjects had the mean stress score of 4.45 based on a scale of 0 and 10. There were only three cases reporting the lack of any stress and two subjects selecting the maximum indicator of stress (i.e., 10). With regard to the correct workplace posture, 29 (56.9%) of the cases stated they had information about this concept; however, only 3 participants (5.9%) had received adequate training on correct workplace posture.

The current study evaluated various tasks in

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dentistry, which are presented in Figure 1 according to their percentage of frequency. The findings of the body map revealed that 43 (84.3%) subjects suffered from musculoskeletal pain in at least one or more regions of their body. According to the results of Table 3, the neck was the most common region experiencing pain (72.7%), while the left leg and arm were the regions in the best condition (6.8%). Moreover, based on the results of BPAI, the total obtained mean score was 44.78±6.74, and the maximum and minimum scores were 64 and 31, respectively.

0

0

10

30

It was also revealed that 21.6% and 78.4%

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2.67

6.75

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of the studied postures were in acceptable and compromised conditions, respectively, indicating that none of the cases' posture was at a harmful level. Table 4 tabulates the results of BPAI comparing different groups in terms of gender, musculoskeletal pain, and training on correct occupational posture. The results of the ergonomic posture of dentists in relation to • Musculoskeletal Disorders Assessment Using BPAI among Dentists

different organs are presented in Table 5.

The stress level and the final BPAI score were also calculated in each of the different tasks under study (Table 6). The results of Pearson's correlation coefficient test indicated that proper posture at work had a significant relationship with work experience and the amount of rest breaks. Furthermore, there was a



Figure 1) Frequency percentage of dentists' tasks

Table 3) Frequency and percent	ge of musculoskeletal disorders amon	g dentists in the last year (n=51)
	<b>0</b>	

Body region	Side	Frequency	Percentage	Body region	Side	Frequency	Percentage
Neck	-	32	72.7	Hand	Right	6	13.6
Shoulder	Right	24	54.5	паци	Left	5	11.4
	Left	17	38.6	XX7	Right	17	38.6
Back	Upper	20	45.5	VV FISt	Left	15	34.1
	Lower	15	34.1	Т.	Right	8	18.2
	Right	7	15.9	Fingers	Left	7	15.9
Arm	Left	3	6.8	Thich	Right	7	15.9
Farragener	Right	4	9.1	Inign	Left	4	9.1
Forearm	Left	7	15.9	Lag	Right	3	6.8
Нір	-	4	9.1	Leg	Left	3	6.8

Table 4) Results of Branson's posture assessment instrument among dentists in terms of gender, disorder, and training (n=51)

training (n=51)									
BPAI level	Gender		Musculoskeletal disorder		Training on correct occupational posture				
	Male	Female	Yes	No	No	Yes			
Acceptable	9 (21.4)	2 (22.2)	9 (22)	9 (21.4)	2 (22.2)	9 (22)			
Compromised	33 (78.6)	7 (77.8)	32 (78)	33 (78.6)	7 (77.8)	32 (78)			

BPAI: Branson's posture assessment instrument

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	Score	2	4	5	6	7	Q	0
	Body region/Posture	3	4	3	U	/	0	9
Leg	Thighs flat/non-flat on chair	88.2	2	-	9.8	-	-	-
	Forward or backward bending	47.1	11.8	19.6	17.6	2	-	2
Waist	Lateral bending	70.6	15.7	7.8	5.9		-	
	Rotation between planes	39.2	19.6	21.6	13.7	3.9	-	2
	Forward or backward bending	11.8	5.9	9.8	43.1	9.8	11.8	7.8
Head/Neck	Lateral bending	17.6	21.6	17.6	29.4	11.8	-	2
	Rotation between planes	43.1	11.8	15.7	15.7	11.8	-	2
Shoulders	Normal or slupmed forward	76	4	12	8	-	-	-
	Level with trunk /elevated above line of trunk	31.4	11.8	3.9	52.9	-	-	-
Wrist	Flexion/extension	-	5.9	17.6	76.5	-	-	-

#### Table 5) Frequency of Branson's posture assessment instrument score in terms of different organs

Table 6)	<b>Stress and Branson's</b>	posture assessment instrument	t scores in different (	dentistry tasks
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Factor		S	tress			BP.	BPAI Score			
Task	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum		
Mandibular fracture repair	5.83	3.04	1	10	45.67	4.35	37	54		
Maxillary fracture repair	3.80	2.38	0	6	42.14	8.17	32	56		
Dental molding	1	1	0	2	40	3.46	38	44		
Maxillofacial neurosurgery	4.5	2.16	2	8	47.50	4.68	41	55		
Mandibular neurosurgery	4	1.29	2	5	45.63	6.76	34	53		
Orthodontics	1	1.41	0	2	37.50	9.19	31	44		
Root canal treatment	4	2.64	2	7	42.67	0.57	42	43		
Dental composite	6.33	3.51	3	10	43.67	8.5	34	50		
Tooth extraction	6	2.82	4	8	57	9.89	50	64		

BPAI: Branson's posture assessment instrument

relationship between age and the number of received ergonomics training courses. Likewise, the relationship between the amount of rest breaks and the number of received ergonomics training courses was found to be significant. In the same vein, the stress level and amount of rest breaks showed a significant relationship with the final BPAI score (P<0.05).

Since the results of the Kolmogorov-Smirnov test were indicative of abnormal distribution (P<0.05), nonparametric tests were applied for analyzing the data. In this regard, the results of

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the Mann-Whitney U and Kruskal-Wallis H tests showed no significant differences among different groups regarding postural conditions and musculoskeletal disorders (P>0.05). In this respect, while 78.6% of the males were suffering from musculoskeletal disorders, 88.9% of the females were experiencing pain. Spearman's correlation coefficient showed a significant relationship between the amount of rest breaks and the final BPAI score (r=-0.494, P=0.001), the number of received ergonomics training courses (r=0.128,P=0.005), and work experience (r=0.314, P=0.04).

In addition, stress had a significant relationship with the final BPAI score (r=0.477, P=0.001). Among the investigated tasks, tooth extraction had the highest BPAI score ( $57\pm9.9$ ), followed by maxillofacial neurosurgery ( $47.5\pm4.68$ ) and mandibular fracture repair ( $45.67\pm4.36$ ), respectively. On the other hand, orthodontics ( $37.5\pm9.2$ ) and dental molding ( $40.67\pm3.46$ ) had the lowest scores.

#### Discussion

Based on the results of this study, a significant percentage of dentists (84.3%) suffered from musculoskeletal pain in one of their organs within the preceding year of the study. The results of the current study are in line with those obtained by Iranian (22, 24, 25) and non-Iranian research (1, 7, 40-42). According to the literature, it seems that between 65% and 95% of dentists suffer from musculoskeletal pain (41, 43). Despite the implementation of control measures and strategies in recent years, these disorders have been on a growing trend even in developed countries (22).

The origins of static postures in dentistry can be sought in the nature of the activities of this profession and their required accuracy, volume of patient referral, lack of breaks during work and therapeutic measures, use of delicate tools, and necessity of performing various maneuvers (1). In line with other similar studies (22, 30, 35, 38, 44), in the current research, the neck (72.7%) was found to be the most frequently affected region of the body.

These findings are in agreement with those obtained by BPAI (Table 3). According to these results, 72.5% and 43.2% of the dentists with the forward neck flexion and neck side flexion obtained the score of  $\geq 6$ , representing harmful levels. The necessity of dental scrutiny and lack of proper light can lead to an awkward neck posture among dentists. It has been shown that in 45% of the cases, the lamp was positioned wrongly over the patient (38). Therefore, assistive devices, such as mirrors or magnifying glasses, can improve neck posture (36, 45).

After the neck, the right shoulder (54.5%) and lower back (45.5%) were found to be the most painful parts, respectively. Due to the fact that most of the subjects were right-handed, and they held their hand away from their body during working, experiencing pain in the right shoulder was inevitable. Additionally, since the current study involved the investigation of the sitting tasks in which the neck and shoulder pains are prevalent (1), our results expectedly revealed that pain in the neck and shoulder had the highest rate.

Mehrdad et al. in 2016 reviewed the literature on back pain incidence from 1984 to 2012 in Iran. In the mentioned study, the prevalence of low back pain among laborers was reported to be about 25% (46). However, dentists still have a higher prevalence of back pain, compared to the laborers. The results of the BPAI, in line with those of the body map, revealed a lumbar posture score of  $\geq 6$  in 47.1% of the subjects, which was indicative of the high risk of lumbar disorders.

The results of quantitative research conducted by Pope-Ford in 2015 showed a prevalence range of 36-60% for low back pain among dentists (13). In the same vein, in a six-month cohort study carried out in Thailand, the waist

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was introduced as the highest painful region among dentists. In the mentioned study, the utilization of vibrating tools, improper posture, exhaustion, and lack of rest breaks were reported as the risk factors for such disorders (14).

Rampel et al. pointed out that in a crowded dental office, proper posture is easily forgotten (47). According to the literature, the use of ergonomic chairs and benefits of appropriate supports for the back, chest, and arms improve the body posture (32). In the present study, the results of BPAI showed that 88.2% of the dentists obtained a score of 3 in terms of thighs flat on the chair, which is indicative of appropriate seat height.

However, regarding that most dental tasks are fulfilled in a sitting position (27), using a proper work-rest cycle and combining standing and sitting tasks can be regarded as the strategies facilitating the prevention of low back pain (48). Although the results of this research, in line with other studies (16, 38, 39, 44), showed no significant difference between women and men in terms of postural conditions and musculoskeletal disorders, the incidence of pain was higher in women than in men. The reason for this minor discrepancy can be the women's body size, muscular strength, and different aerobic capacity (16).

In the present study, correct posture during work had a significant relationship with work experience and the amount of rest breaks (P<0.05). Likewise, a significant relationship was observed between the amount of rest breaks and the final BPAI score. In other words, as the amount of work experience and rest breaks increased, the prevalence of musculoskeletal pain decreased. Moreover, the findings of studies have indicated that a workforce with less experience is more likely to develop musculoskeletal injuries (39).

In a study performed by Khan et al., it was revealed that the experienced workforce suffered from less pain in their musculoskeletal system (15). It should be also noted that many dentists quit their profession or do not perform heavy tasks as they grow older or gain more work experience. Another fact leading to the incidence of pain is the amount of performed activities. Researchers have shown that there is a relationship between the dentists' workload and musculoskeletal pain incidence (7), as well as between the working hours per week and ergonomic pain (22). Moreover, in the present study, the number of received ergonomics training courses showed a correlation with the final BPAI score (r=0.128, P=0.005).

Many studies have reported that ergonomic problems in the dental profession begin during the early years of university (6, 15, 16, 31, 38, 42, 44) and aggravate in the final years of study (7), reaching to 93% (15). Although the ergonomics course (with a credit point value of 0.5) is included in the schedule of dental students, it seems that the presentation of this course to students during the first semester has not been able to encourage the adoption of ergonomic behaviors by students in the second semester.

Shirazi et al. in 2015 reported that 80.8% of students were unaware of their body posture while working (44). Additionally, Abdolalizadeh et al. emphasized the lack of dentists' knowledge about the role of ergonomics in the health of the musculoskeletal system (26). Nonetheless, continuous education and knowledge improvement of individuals can enhance proper body posture (6) and determine their future behaviors accordingly (16). In line with the above studies, only 5.9% of the subjects participating in this study had received adequate training on desirable physical postures at work, highlighting the need for regular and organized training.

Given the emphasis of the previous studies on the role of psychosocial factors, such as stress, on the incidence of musculoskeletal disorders (1, 7, 13, 16, 30, 40), the stress level of the participants of this study was evaluated on a range of 0-10. According to the results tabulated in Table 6, composite restoration resulted in the highest mean stress score  $(6.33\pm3.51)$  among other dentistry tasks. On the other hand, orthodontics and dental molding were reported to gain the lowest stress scores. To elaborate, regular daily exercise, stretching exercises between working hours, adequate rest breaks between therapeutic activities, and training can reduce stress in this profession (22).

According to the literature, a small portion of dentists regularly perform exercises. This rate has been reported by Madan et al. as only 5% (42); however, Rafiei et al. (2015) reported a higher rate for this group (26.3%) (2). Apparently, people's motivation for doing regular exercise can be improved by changing the standards of living and developing a culture of public sports in cities. In this respect, some helpful activities are recommended to relieve stress and fatigue, including performing stretching exercises between treatment processses, avoiding sitting for long periods, using a suitable chair, and moving the work position from sitting to standing and vice versa.

The results of the present study were indicative of a high level of ergonomic disorders among the dentists. Some of the risk factors for musculoskeletal disorders include repetitive activities and lighting problems (30), vibrating tools and lack of physical activity (22), lack of continuous monitoring of ergonomic status (38), insufficient rest among therapeutic tasks (33), lack of knowledge and proper training (16), morphological factors (i.e., body weight and body mass index), high workload (6), psychosocial factors (e.g., stress and job dissatisfaction) (40, 49), tools and equipment (32), and proper ventilation and optimal temperature (12). Regarding this, posture awareness strategies (50), preventive strategies (51), and workplace-specific design (52) should be used to reduce the severity of musculoskeletal disorders or eliminate the risk of such conditions.

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# Conclusion

The review of literature has well established and proven the existence of musculoskeletal disorders in dentistry over the past 50 years. Regarding this, extensive efforts have been made to manage and eliminate these disposed risks. However, this disorder has been on an increasing trend and even affected dentistry students. In this study, the mean working hours of the dentists was obtained as 45.89 h per week, which is higher than the standard (34 h), indicating a risk factor for ergonomic disorders (51). Therefore, it is recommended to develop such strategies as improving workplaces, reducing workload, or combining activities with training and strategies to improve conditions and posture of the studied dentists.

# Footnotes

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#### **Conflict of Interest**

The authors declare no conflict of interest.

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