



## Assessment of ergonomic condition of Iranian dentists using RULA technique and its correlation with musculoskeletal disorders

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Submitted: 06 February 2023; Accepted: 18 March 2023; Published: 09 April 2023

### ABSTRACT

**Objectives:** The aim of the present study was to evaluate the ergonomic status of Iranian dentists using the Rapid Upper Limb Assessment (RULA) technique and its correlation with musculoskeletal disorders (MSDs).

**Materials and Methods:** This descriptive study was conducted on 152 dentists practicing in Ahwaz city, Iran. The ergonomic status of dentists was evaluated using the RULA method, and the prevalence of MSDs was assessed through the Nordic musculoskeletal questionnaire. Data were analyzed by the regression model, Chi-square test, and Mann-Whitney test ( $\alpha=0.05$ ).

**Results:** The highest levels of MSDs during the past 12 months were reported in the neck (71.1%) followed by the upper back (59.2%), wrist (55.3%), lower back (53.3%) and shoulders (52%). The RULA score was 3 or 4 in 38.8%, 5 or 6 in 57.2%, and 7 or higher in 3.9% of dentists. No significant correlation was noted between the RULA score and MSDs in the wrists, thighs, buttocks, shoulders, and ankles ( $P>0.05$ ). However, dentists with neck ( $P<0.001$ ) and arm ( $p=0.017$ ) pain had significantly higher RULA score than those without pain in these areas.

**Conclusion:** The ergonomic status of Iranian dentists practicing in Ahwaz city was not satisfactory, and they had relatively high prevalence of MSDs, which calls for educational courses on this topic and measures to correct their posture.

**Keywords:** Dentists; Musculoskeletal Diseases; Ergonomics

### INTRODUCTION

According to the National Institute for Occupational Safety and Health of the U.S, musculoskeletal disorders (MSDs) refers to specific conditions that affect the nerves, tendons and muscles, and support some structures including intervertebral discs.

MSDs include a wide range of conditions with different severities ranging from mild periodic to chronic debilitating symptoms [1]. MSDs have turned into a dilemma in dental occupation. The majority of dental clinicians experience muscle pain during their professional life;

although a temporary backache or neck pain may not seem important, frequent ignoring of such pains may result in development of a chronic disability [2]. Risk of MSDs manifesting as pain in different body parts is high in dental profession due to the repetitive nature of work, long working hours in static positions without sufficient breaks, incorrect posture during the procedures, application of excessive force, and use of unsuitable tools and instruments [3]. A previous study reported the prevalence of backache, neck pain, upper back pain, and shoulder pain to be 39%, 32%, 42%, and 8%, respectively, in dental clinicians [4]. Such complications are mainly attributed to unique characteristics of dental profession, such as using precise instruments in a small environment (oral cavity), fine hand movements, and having inappropriate posture for long hours, and often require treatment [5]. Precise complex intraoral procedures require comprehensive attention of dental clinicians; thus, a more suitable ergonomic position is often sacrificed for a better vision of the field of work; although a preliminary study showed that straight body posture does not necessarily decrease the quality of treatment [6]. Forward head posture (FHP) is a head and neck posture disorder, in which, the head is positioned in front of the body's vertical midline. Several factors such as over-bending of body, and abnormal posture during occupational activities like inappropriate sitting positions can lead to FHP. An inappropriate posture may damage the joints and some other connective tissues, and lead to pain and disability. The correlation of neck pain and FHP has been previously documented [7]. It has been stated that FHP is probably one reason for neck pain in dental clinicians, especially those with over 15 years of clinical work experience [8]. Not paying attention to physical occupational disorders leads to disability, psychological problems, decreased quality of work, occupational dissatisfaction, discouragement, early retirement, and even irreparable injuries [9,10].

Posture is defined as automatic and unconscious position of different body organs and limbs [11]. MSDs have a close correlation with posture during work; inappropriate posture is among the

most significant risk factors effective in the development of MSDs [12].

Several methods have been developed to assess the ergonomic status in different occupations such as the Nordic musculoskeletal questionnaire, Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA), and Rapid Office Strain Assessment [13]. The RULA method has been used by a high number of researchers for assessment of ergonomic status and risk of development of MSDs in different occupational environments. The RULA method is used for fast assessment of posture pressure and evaluation of MSDs, and is particularly suitable for static works [14,15]. RULA was developed in 1997 for fast assessment of upper limbs. It is primarily used for assessment of occupational ergonomic disorders related to upper limbs. RULA requires no specific tools and equipments. Parts of the body assessed in RULA include the neck, back, arms, wrist, and shoulders [16]. Many studies have reported high prevalence of MSDs in dental clinicians; however, only a few of them used RULA for posture assessment. Also, the correlation of RULA score and prevalence of MSDs has not been extensively evaluated. Thus, the main objective of the present study is assessing the ergonomic status of Iranian dentists by the RULA method and its correlation with MSDs.

## MATERIALS AND METHODS

This descriptive study was conducted on all general dentists practicing in Ahwaz city, Iran (n=260). According to the Morgan's table, which yields the maximum possible sample size, the sample size was calculated to be 152 in the present study.

### *Eligibility criteria*

The inclusion criteria included subjects with at least 2 years of clinical experience and without systemic disease. Dentists unwilling to participate in the study were excluded. Dental clinicians were enrolled by convenience sampling, and signed informed consent forms prior to their participation.

### **Data collection**

The Nordic musculoskeletal questionnaire, which is a self-reported questionnaire developed in 1987 with a reliability of 87% [17] was administered among 152 dentists electronically. It contains questions about pain in the upper back, lower back, neck, and wrist in the past 12 months, and past 7 days, and whether the pain in the past 12 months led to disability and absence from work. This questionnaire has a general and a professional part. The general part aims to do a general assessment and focuses on MSD signs and symptoms in the entire body while the professional part performs in-depth analysis of MSD signs and symptoms in specific areas such as back, neck, wrist, hands, and shoulders. In the present study, the general part of the questionnaire was dedicated to determining the MSDs prevalence, which divides the body into 9 sections of neck, upper back, lower back, shoulders, arms, wrists, hands, buttocks, thighs, knees, and ankles. Each section has 3 questions with yes/no answer choices:

Did you experience problems such as pain, dysesthesia, tingling, or burning sensation in these areas in the past 12 months?

Did you experience problems such as pain, dysesthesia, tingling, or burning sensation in these areas in the past 7 days?

Did your physician advise you to refrain from routine activities such as going to work, working from home, or leisure activities due to problems in these areas?

Demographic information of patients including their age, gender, work experience, exercise, and hand preference was also collected by using a questionnaire.

The RULA method was applied to evaluate the risk of development of MSDs. The posture of dentists was photographed during dental procedures, and the most repetitive postures were selected for further assessment. The photographs were assessed by Digimizer software, and the angles required for calculation of muscle posture score were measured.

In the RULA method, the posture of different parts is observed, and scored based on their specific angulation, having a rest, and the magnitude of applied load to the respective limb/organ according to the standard scoring system. High scores indicate higher musculoskeletal tension. The posture scores of different organs and limbs are summed, and the final score is determined by taking into account the muscle activity and the applied load, which would indicate the risk of injury. The final score is categorized as follows:

Level I: A final score of 1 or 2 shows an acceptable posture if it is not continue for long hours, or is not severely repeated.

Level II: A final score of 3 or 4 indicates that more investigations are required; posture change, and ergonomic interventions may also be required.

Level III: A final score of 5 or 6 indicates that more investigations, posture change, and ergonomic interventions are necessary in near future.

Level IV: A final score of  $\geq 7$  indicates that further investigations, posture change, and ergonomic interventions are immediately required.

Data obtained by the RULA method and Nordic musculoskeletal questionnaire were entered into SPSS version 22. Kolmogorov Smirnov test and Q-Q chart were used to evaluate the normal distribution of data. Data were analyzed by the regression test, Chi-square test, and Mann-Whitney test. A P-value less than 0.05 was considered significant.

### **RESULTS**

Demographic information of participants is represented in Table 1. The mean age of participants was  $30.41 \pm 6.22$  years and their mean weight was  $70.86 \pm 16.08$  kg. They had a mean work experience of  $5.34 \pm 5.28$  years, and mean weekly work hours of  $28.25 \pm 14.27$  hours/week.

**TABLE 1:** Demographic information of participants

Variable	Category	Number	Percentage
Gender	Female	88	9.57
	Male	64	1.42
Being left-handed	Yes	20	2.13
	No	132	8.86
Duration of exercise at home	0	32	1.15
	1 hour	74	7.48
	2-3 hours	37	3.24
	>3 hours	18	8.11
Total		152	100
		Mean	Std. deviation
Age (years)		41.30	22.6
Weight (kg)		86.70	8.16
Duration of occupation (hours)		34.5	28.5
Weekly work hours		25.28	27.14

Table 2 shows the prevalence of MSDs in general dentists practicing in Ahwaz city. The highest prevalence of MSDs in the past year was found in the neck (71.1%), followed by the upper back (59.2%), wrists (55.3%), waist (53.3%) and shoulders (52%).

**TABLE 2:** Prevalence of MSDs in general dentists practicing in Ahwaz city

MSDs	Past 7 days		Past 12 months	
	Number	Percentage	Number	Percentage
Wrist	46	3.30	84	3.55
Neck	60	5.39	108	1.71
Shoulders	35	0.23	79	0.52
Arms	14	2.9	19	5.12
Buttocks and thighs	12	9.7	18	8.11
Ankles	9	9.5	20	2.13
Lower back	47	9.30	81	3.53
Upper back	34	4.22	90	2.59
Total	152		152	

The results showed that the mean score of ergonomic status of dentists according to the RULA method was 4.89 (range 3 to 7). According to the final RULA score, 38.8% had RULA score of 3 or 4, 57.2% had RULA score 5 or 6, and 3.9% had RULA score of 7 or higher (Table 3).

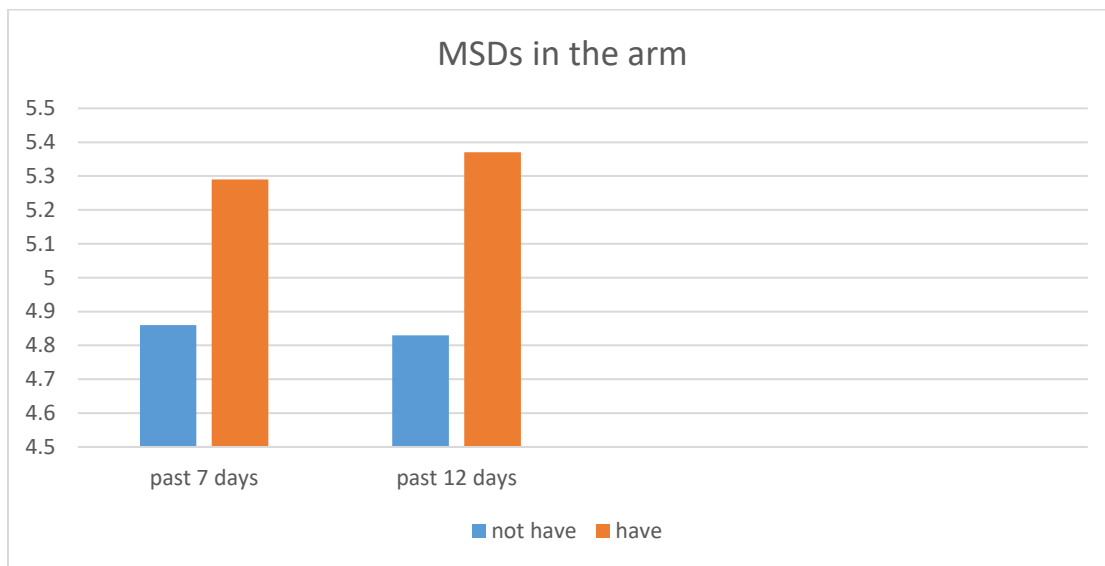
**TABLE 3:** Ergonomic status of dentists according to the RULA method

Variable	Number	Mean±SD	Minimum	Maximum	RULA final score	Number	Percentage	Necessity of corrective measures
RULA ergonomic status	152	0.88±4.89	3	7	1 or 2	0	0%	Not necessary
					3 or 4	59	8.38%	Better be initiated

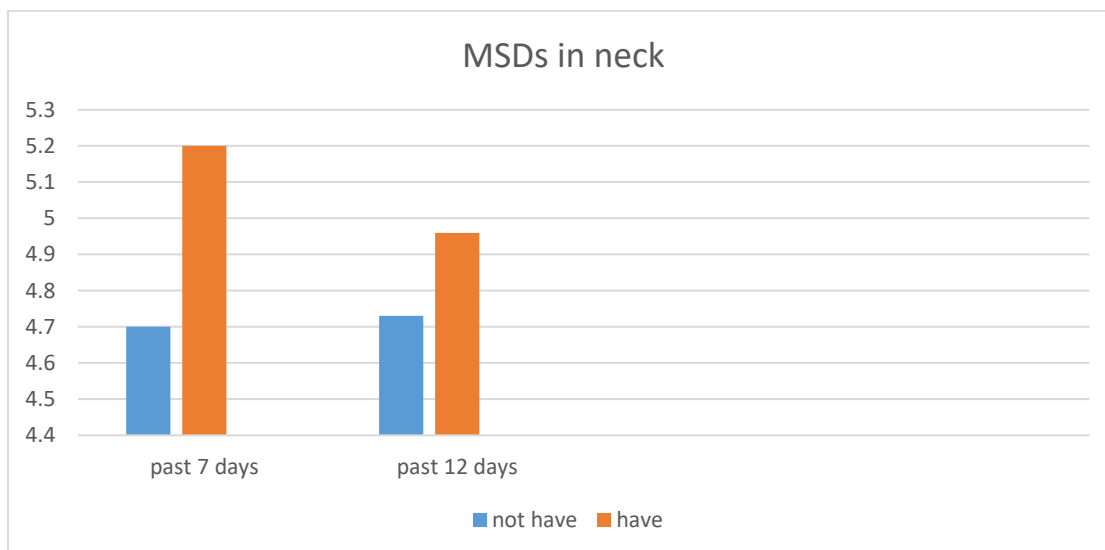
					5 or 6	87	2.57%	Necessary in near future
					7 and higher	6	9.3%	Immediately necessary
					Total	152	100%	

SD: Standard deviation

There was no notable association between the RULA score and MSDs in the wrists, thighs, buttocks, shoulders, and ankles ( $P > 0.05$ ). However, dentists with neck ( $P < 0.001$ ) and arm ( $p = 0.017$ ) pain had significantly higher RULA score than those without pain in these areas (Figures 1 and 2).



**FIGURE 1:** Mean RULA score according to the prevalence of MSDs in the arm



**FIGURE 2:** Mean RULA score according to the prevalence of MSDs in the neck

### DISCUSSION

This study assessed the ergonomic condition of Iranian dentists using the RULA and its

correlation with MSDs. According to the results, the prevalence of MSDs in the past 12 months was highest in the neck (71.1%), followed by

upper back (59.2%), wrist (55.3%), and shoulders (52%), which was in agreement with the results of Meisha et al, [18] in Saudi Arabia and Senosy et al, [19] in Egypt. The mean age of dentists evaluated in this study was  $30.41 \pm 6.22$  years, and 57.9% were females. The mean score of ergonomic status of dentists according to the RULA method was 4.89 (range 3 to 7). The final RULA score of 38.8% was 3 or 4, indicating that corrective measures had better be started; in 57.2%, the RULA score was 5 or 6, indicating that corrective measures were necessary in early future. This score was 7 or higher in 3.9%, indicating the need for immediate measures; these results are in line with the findings of Judith Earnesty et al [20]. Also, the RULA score had a significant correlation with MSDs in the neck and arms, and patients who had pain in these areas acquired a significantly higher RULA score.

MSDs are highly common in dentists. FHP, bending, and crouching for a better vision apply excessive force on the neck. Correct posture during a dental procedure can prevent a high percentage of MSDs. Ilbeigi et al, [21] also reported that the prevalence of MSDs in the last 12 months was the highest in the neck (56.3%), followed by shoulders (56.3%) and wrists (51.3%). Their findings are consistent with the results of this study; however, order of prevalence of different MSDs varied in their study from that in the present study, which can be due to different occupational environments, and method of calculation of RULA score. The results of Aminian et al.'s [22] study showed that the highest MSDs prevalence in male dentists was found in the neck (53.2%), followed by shoulders (45.2%) and wrists (36.5%). This is in line with the results of the present study. However, they did not assess the upper and lower back in their study. ZakerJafari and YektaKooshali [23] in a systematic review investigated the MSDs prevalence in Iranian dentists. Similar to the results of the present study, they reported that the lowest prevalence of MSDs was in feet (10.5%), while the highest was in the neck (51.9%) [23]. In another study, Rabie et al. [24] also reported that MSDs were most common in the neck, which was similar to the present findings. Also, 62% were level 2, 34%

were level 3, and 4% were level 4, which were in line with the results of our study but with lower intensity, which is probably due to better posture of dental clinicians in their study, which can be attributed to high percentage of specialists in their study population (57.6%). Specialists often receive better training regarding correction of their posture, and practice more to have a suitable ergonomic status; thus, they often acquire a better RULA score, and were categorized in level 2 in the study by Rabie et al [24]. Ahmadi Motamil et al. [25] investigated the MSDs prevalence in Hamadan dentists and reported that the neck (49.7%) and wrist (47.8%) were the most common MSDs affected organs in the past 12 months, which were in accordance with the present findings. However, they did not assess the muscular posture and ergonomic status. Askaripoor et al. [26] reported that MSDs in the past 12 months were more prevalent in the neck (58%), hands and wrists (54%), lower back (46%), shoulders (37%) and feet (4%), respectively. According to REBA, 90% of dentists necessarily required corrective measures, which was in line with the findings of our study. Ebrahimian et al. [3] reported that lower back pain had the highest prevalence in their study (46.7%), followed by neck pain (27%). Their results were different from the present findings. Also, all clinicians were at risk according to REBA and required corrective measures, which was in line with the findings of our study. Of all, 78.3% had moderate risk, and the rest required immediate corrective measures. The difference between the results of this study and ours can be attributed to the use of different methods in the two studies; since they used the REBA method, while the RULA method was used in the present study. Koosha et al. [27] used Nordic musculoskeletal questionnaire and reported the highest frequency of MSDs in the neck (60%), lower back (58%), and upper back (46%), and the lowest frequency of MSDs in the thighs (5%) and knees (6%). They used REBA method and reported that 6% were at very high risk, 17% had high risk, and 25% had moderate risk, and required immediate, fast, and necessary corrective measures, respectively. Their results regarding the prevalence of MSDs were in line with the present findings, while their findings

regarding the risk levels were different from the present results; the latter can be due to different method of assessment (REBA versus RULA). Rafie et al. [28] reported that the pain in the neck (53.9%), shoulders (43.8%), and wrists (39.2%) were the most common cases. According to the RULA score, 18.2% were level 2, 57% were level 3, and 24.8% were level 4, which were comparable with the values obtained in the present study. However, the percentage of clinicians in level 4 was higher in their study probably due to longer working hours of dentists in their study. They also assessed the correlation of RULA score and MSDs and found a significant correlation in the neck, shoulders, and arms. Similar results were obtained in the present study. Tamrooiy et al. [29] found that MSDs were most prevalent in the neck (78.3%), followed by shoulders (76.4%), wrists (68.5%), lower back (55.4%) and knees (48.7%). According to the RULA score, 21% were level 2, 54% were level 3, and 21% were level 4. The prevalence of knee pain and percentage of dentists in level 4 in their study were different from the corresponding values in the present study, probably due to different study populations or higher mean age of participants in their study.

Dehghan et al. [30] articulated that neck pain was the most prevalent pain with a frequency of 59.5%, followed by lower back pain (54.5%), shoulders pain (41.4%), and wrists pain (38.4%), which were in agreement with the findings of this study; however, they found a lower prevalence of wrist pain than that found in the present study.

This study was conducted only on dentists practicing in Ahwaz city. Future studies on dentists practicing in other parts of Iran are required. Also, the correlation of lower and upper back pain and RULA score should be further investigated. Moreover, studies are required to assess the correlation of using some advanced instruments such as dental loupe, dental microscope, and different units with ergonomic status of dentists. Last but not least, posture of different specialists and the prevalence of MSDs among dentists with different specialties should be compared.

## CONCLUSION

The ergonomic status of Iranian dentists practicing in Ahwaz city was not satisfactory, and they had relatively high prevalence of MSDs, which calls for educational courses on this topic and measures to correct their posture.

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