

## Ergonomic Evaluation of Work Conditions in Qazvin Dentists and its Association with Musculoskeletal Disorders Using REBA Method

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### Abstract

**Background and Aim:** Dynamic and static activities in dentistry, cause musculoskeletal disorders but dentists do not have enough awareness about effects of ergonomic factors on their health. The aims of this study were to assess ergonomic conditions in dental workstation in Faculty of Dentistry, Qazvin University of Medical Sciences, using REBA method, to investigate the relationship between REBA scores and musculoskeletal disorders and finally, to present corrective solutions.

**Materials and Methods:** In this cross-sectional study posture assessment of 63 participants were implemented by the REBA method. In order to investigate incidence of musculoskeletal disorders, the standard Nordic questionnaire was used. Data were processed using regression and chi-square tests and the significance level was determine at  $P < 0.05$ .

**Results:** The results indicated that 30.2% of participants obtained from 11 to 15 scores (very high risk level). Results of the Nordic questionnaire indicated that the highest musculoskeletal disorder report was related to neck region with 50.8 %.

**Conclusion:** The results showed that 30.2% from the final REBA scores had very high risk level and 51.7% high risk level means that essential corrective and urgent corrective measures are required respectively.

**Key Words:** Dentistry - Musculoskeletal disorders – Questionnaire - Ergonomics

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Received: 19 Feb 2011  
Accepted: 22 May 2012

Journal of Islamic Dental Association of IRAN (JIDAI) / Fall 2012 / 24 / (3)

### Introduction

Musculo-skeletal injuries associated with occupation are among the most important occupational problems worldwide. Unfavorable occupational body position is one of the most important factors in these injuries. Other risk factors include genetic predisposition, aging and emotional stress. Such injuries bear negative social, economical and political complications for human societies. In 1995 direct and indirect costs of musculoskeletal injuries

in the United States was reported to be  $5 \times 10^{10}$  dollars [1]. Evaluation of the work condition using relevant evaluation methods is beneficial in recognition of ergonomic risks due to unfavorable body positions and prediction of occupationally induced musculoskeletal disorders. In dentistry, dynamic and static activities predispose dentists for musculoskeletal disorders. Dentists are usually unaware of the ergonomic factors and their role in their musculoskeletal health [2]. Finsen et al evalu-

ated the risk factors of MSDs on a number of Danish dentists. They revealed that 65% of the dentists suffer from neck and shoulder pain and 59% of the subjects had back pain [3]. National Institute of Occupational Health in Denmark, Copenhagen, conducted an investigation entitled as "biomechanical aspects of neck posture during dental work" in 1999 and declared that increased knowledge and awareness about neck anatomy helps subjects understand how different tissues are subjected to pressure [4]. Thornton et al concluded that instructing the biomechanical principles should be extended to the clinical settings as well. Also ergonomic awareness programs should be expanded so that clinical principles be covered [5]. Saremi and colleagues indicated that neck and shoulder pains were the most significant complications for the dentists. They also depicted that more than 30% of the dentists are considered as high-risk individuals for these disorders [6]. Rapid Entire Body Assessment (REBA) is an observation-based method developed according to Rapid Upper Limb Assessment (RULA) for occupations in which several injurious static and dynamic conditions exist. Nasle Seraji and co-workers also stated that pains in neck and back region are among the most frequent ergonomic hazards in dentists, with a more frequent observation in women than in men [7]. Mojabi et al depicted that neck pain, back pain, shoulder pain and combined neck, back and shoulder pain was observed in 27.1%, 18.6%, 10% and 11.5%, respectively [8]. To the best of our knowledge, well known evaluation methods are rarely used to investigate occupational disorders in dentists, therefore the aim of this study was to evaluate ergonomic occupational positions of dental professionals using Rapid Entire Body Assessment (REBA).

### Methods and Materials

In this descriptive cross sectional study, a total of 63 dentists working in departments of prosthodontics, endodontics, operative dentistry, pedodontics, periodontics, and treatment clinic were studied. In order to evaluate angular measurements of the

body parts and evaluation of the body status during work direct observation and REBA method was used. Then interpretation of the final scoring of the REBA method was carried out using a table. (See table 1) [9] In order to evaluate musculoskeletal disorders of the studied community Nordic Musculoskeletal Questionnaire (NMQ) was used. This questionnaire was prepared and subjected to validity and reliability testing in 1989 to 1991 by some Scandinavian investigators. Use of NMQ is based upon interview and observation of the occupational environment. After recording the ergonomic specifications of the occupational environment as well as the pertinent physical influences, the obtained results are analyzed and the susceptible points are marked [9]. In this study, the data obtained from the REBA method and NMQ was analyzed by univariate logistic regression analysis and chi square test using SPSS 13.0 software for Windows. In order to interpret the relationship between dependent and independent variables odds ratio was used and the confidence level was set at 95%.

### Results

Twenty-nine subjects (46%) of the studied community were men and 34 (54%) were women. The mean age, weight, height, and work experience in the studied population were  $28.38 \pm 7.37$  years,  $64.68 \pm 4.4$  Kg,  $168.74 \pm 8.46$  cm and  $8.28 \pm 6.44$  years, respectively. It was shown that 30.2% of the studied population had an extremely high risk level who required urgent corrective remedies.

According to NMQ the most frequent MSD was reported to occur in neck and back region and the least frequent area involved was elbow. Within a year, absences from the work due to the low back pain had the highest frequency (9.5%). During the study period, the most frequent and severe pain sensation was felt in cervical area. Work limitations and decreased work activity occurred most frequently due to the subjects' low back pain. There was not a statistically significant relationship with the final REBA score in different body parts and the subjects' demographic data (See table 2). Regression analysis showed that there was not any

**Table 1:** Interpretation of the rapid entire body assessment (REBA)

Final REBA score	Risk level	Corrective measure priority level	Corrective measure necessity and timing
1	negligible	0	Unnecessary
2-3	low	1	Might be necessary
4-7	moderate	2	Necessary
8-10	high	3	Necessary (as soon as possible)
11-15	Very high	4	Necessary (urgent)

**Table 2:** The relationship between the final REBA score and demographic data using chi square test

P.V	$\chi^2$	Demographic data
0/95	0/004	Age
0/95	0/003	Weight
0/88	0/02	Height
0/53	1/27	gender
0/88	0/02	Job field
0/93	0/007	Job experience
0/88	0/02	Working habit
0/40	1/83	Emotional stress
0/25	2/73	Sports
0/71	0/66	Smoking

significant difference between the scores obtained from the REBA method for any part of the body and the self-reported pain of the same region within the past year (See table 3).

**Table 3:** Relationship between the final REBA score and pain in different parts of the body within the study period of 1 year based on the regression analysis

CI	OR	Body part
0/6-1/1	0/82	Neck
0/8-1/3	1/01	shoulder
0/82-1/36	1/05	Wrist
0/71-1/53	1/04	Leg
0/74-1/2	0/94	Back
0/5-1/56	0/88	Elbow

Analysis of the qualitative risk factors revealed that women complained of pain in various parts of the body more than did men and those who were smokers also had more complaints with respect to those who were not (See table 4). Regression

analysis showed that those who do not have regular exercise activities are more prone to have shoulder problems compared with those who do. However, there was no statistically significant relationship between other variables and pain in other parts of the body.

### Discussion

Among MSDs reported by the study population, pains and disorders of the cervical region had the highest frequency (50.8%), followed by the low back pain (42.9%), discomforts of the leg (30.2%), shoulder (28.6%), hand-wrist (23.8) and knee (22.2%). Similar investigations also reported that the cervical area was the most frequently involved

region, followed by low back pain, and shoulder discomforts [10]. Undoubtedly, the reason for such similarity is the nature of occupational positions in dental work.

According to the NMQ only 3 subjects (4.8%) had cervical injuries. The rates of injuries to shoulder and back were 3.2 and 4.8 percent, respectively. Although the frequency of previous injuries was low among the subjects, inadequate training, lack of continuous monitoring, lack of attention to the correct ergonomic guidelines, unfavorable designing of the work station and instruments, and work anxiety lead to unfavorable work positioning, giving rise to major discomforts. It is suggested that ergonomics be taught in pre-clinical education as well as continuing educational programs.

The mean REBA score for the arm was 3.17 showing that it had a more than 90 degrees anterior movement or was abducted from the body. Of course, upward movement of the shoulders and/or use of arm-rests while working was influential in

**Table 4:** Frequency of qualitative risk factors according o the prevalence of MSDs in subjects having pain sensation

Risk factor		Pain sensation in different parts of body					
		neck	shoulder	back	elbow	wrist	leg
<b>gender</b>	male	38/7(24)	29/4(19)	39/3(25)	33/3(21)	40(25)	14/3(9)
	female	61/3(39)	70/6(44)	60/7(38)	66/7(42)	60(38)	85/7(54)
<b>Job category</b>	surgery	9/7(6)	11/8(7)	7/1(4)	33/3(21)	20(13)	0
	periodontics	19/4(12)	11/8(7)	21/4(14)	33/3(21)	20(13)	14/3(9)
	pedodontics	6/5(4)	11/8(7)	10/7(7)	0	13/3(8)	0
	Operative dentistry	22/6(14)	23/5(15)	28/6(18)	33/3(21)	13/3(8)	14/3(9)
	endodontics	22/6(14)	11/8(7)	14/3(9)	0	13/3(8)	42/9(27)
	prosthodontics	19/4(12)	29/4(19)	17/9(11)	0	20(13)	28/6(18)
<b>Work habit</b>	Right-handed	96/8(61)	100(63)	92/9(59)	100(63)	93/3(59)	100(63)
	Left-handed	3/2(2)	0	7/1(4)	0	6/7(4)	0
<b>Emotional stress</b>	no	20(13)	31/2(20)	28/6(18)	33/3(21)	26/7(17)	14/3(9)
	little	23/3(15)	25(16)	21/4(14)	33/3(21)	20(13)	42/9(27)
	moderate	50(31)	43/8(27)	46/4(29)	33/3(21)	53/3(33)	14/3(9)
	severe	6/7(4)	0	3/6(2)	0	0	28/6(18)
<b>Sports activity</b>	Very severe	0	0	0	0	0	0
	yes	51/6(33)	76/5(48)	53/6(34)	33/3(21)	53/3(34)	42/9(27)
	no	48/4(30)	23/5(15)	46/4(29)	66/7(42)	46/7(29)	57/1(36)
<b>smoking</b>	no	9/7(6)	17/6(11)	17/9(11)	0	20(13)	0
	yes	90/3(57)	82/4(52)	82/1(52)	100(63)	80(50)	100(63)

the resultant mean. It is suggested that an arm-rest be designed to reduce pressure from the muscles of the neck and shoulder region [11]. The most important reason for increased REBA mean for arm was due to unfavorable work-station design, unfavorable position of the instrument table, lack of assistance, inability to regulate stool height, and lack of ergonomic working style by the dentist.

It was shown that there was a 20-60 degree forward or sideward flexion of the trunk. This can be attributed to the unfavorable work positioning, unsuitable designing of the work station, inadequate ability of the dentists to use dental mirrors for indirect vision, unfavorable arrangement of the dental instruments, as well as lack of ergonomic working styles by the dentists. Use of magnifying devices and a 12-25 cm distance as well as 15-45 degree angle of vision for the dentist is highly recommended. In addition, use of rests for the chest area

is recommended to decrease biomechanical loads to trapezoid muscle [12,13]. More than 20 degrees of forward and sideward flexion of the neck is an interpretation of the REBA mean of 2.92 for this organ, which is the unfavorable position of the neck that results in 50.8% of the disorders. Unsuitable lighting conditions can be added to the aforementioned list. It appears that, use of dental mirrors for indirect vision can significantly prevent such disorders. A 105 degree angle between the trunk and the leg dictated by the working stool as well as a 10- to 20- degree forward cant of the seat is essential for a better vision and a less cervical and lumbar flexion [14,15]. More than a 15-degree angle for the hand wrist toward radius and ulna is depicted by the mean REBA score of 2.36. Unfavorable working instruments, inadequate training, lack of positional monitoring and in some cases static activity of this organ are the major culprits.

A less than 60 degree or a more than 100 degree flexion in arm is detected based on the score 2 of REBA method. This is attributable to a lack of proper vertical positioning by the dentist as well as unfavorable design of the workstation. The ideal working level height should be set 5 to 10 cm below the elbow. In addition, decreased static and dynamic activities can occur through diminishing the working times and including work-rest cycles to prevent lactic acid increase and the resultant pain and fatigue in different organs of the body. Also stretch exercises between patients, as well as regular weekly programs for swimming and walking can increase aerobic power and tackle the occupational problems down [3,16]. It was concluded that corrective measures should be prioritized in 51.7% of the subjects considered as high-risk individuals as early as possible. On the other hand, the extremely high-risk patients (30.2%) require urgent corrective measures to prevent disease. Eight subjects were categorized as medium-risk patients. They were in need of the corrective measures, but it was not considered urgent. Nasle Seraji and colleagues stated that 33% of the people are urged to lose their jobs within the previous week. Also, it was stated that work limitations were noted due to cervical (15%), shoulder (8%) and lumbar (35%) disorders in the study population [7]. Saremi et al declared that near 60% of the people were categorized as medium- and 30% as high-risk individuals. Such results were contradictory to our investigation. There was an agreement between our results and those of Saremi et al in that, none of these two studies could establish a significant relationship between the final REBA score and demographic data, including age, sex, weight, work experience, job category, emotional stress, as well as smoking ( $p>0.05$ ). [6]

Subjects younger than 25 and older than 55 years had higher REBA scores than other age groups. This could be attributed to inadequate experience in the former and musculoskeletal weakness in the latter. Subjects weighing between 80 to 89 kg had the lowest REBA score, but those who weighed more than 90 kg showed the highest REBA score.

Therefore, it can be said that people with higher body mass index (BMI) do not have enough experience in taking appropriate working postures.

Participants whose heights were between 150 to 159 cm had the highest REBA score and those who were more than 180 cm had the least score. In case higher stature is proportionate with the person's weight, better correspondence ensues with the workstation.

Work experience is coordinated with age, so that higher REBA scores were recorded for dentists with less than 5 and more than 20 years of experience. As stated previously, this can be justified by the inexperience of the former and caducity of the latter.

Higher REBA scores were recorded for dentists working in prosthodontics and surgery departments, while the lowest score was recorded for dentists of the periodontics department. According to the fact that static activities are increased in department of prosthodontics, higher REBA scores for this group of dentists is justifiable. Nature of occupational difficulties in department of surgery may cause dentists to neglect proper posturing. Lower REBA scores in department of periodontics might be attributable to ergonomic monitoring of the personnel.

Statistical analysis showed that there was a significant relationship between the final REBA score and low back pain ( $p<0.05$ ). According to OSHA (Occupational Safety and Health Administration), REBA technique is a suitable means to determine ergonomic risks and is advised by this administration [17].

## Conclusion

Final REBA scores showed that 51 subjects (81.9%) were categorized as high- and extremely high-risk individuals. Findings of the NMQ indicated that the most frequent disorders were related to the cervical area (50.8%). Sitting posture was considered an important factor in lumbar disorders. Paying attention to lumbar support and preventing flexion and torsion in this area during dental practice has a pivotal role in reducing lumbar disorders.

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