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

Mohammad Khandan	extsuperscript{a}, Alireza Koohpaei	extsuperscript{b}, Mozghan Shahbazi	extsuperscript{c}, Zahra Allahdadi	extsuperscript{c}, Sakineh Abdi Zarin	extsuperscript{c}

	extsuperscript{a} MSc in Ergonomics, Department of Occupational Health and Safety, Faculty of Health, Qom University of Medical Sciences, Qom, Iran

	extsuperscript{b} PhD in Occupational Health, Department of Occupational Health and Safety, Faculty of Health, Qom University of Medical Sciences, Qom, Iran

	extsuperscript{c} Student Research Committee, Qom university of Medical Sciences, Qom, Iran

*Correspondence should be addressed to Dr Alireza Koohpaei, Email: koohpaei19@yahoo.com

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.

Keywords:
- Dentistry
- Ergonomic risk factors
- Musculoskeletal disorders
- Posture evaluation

Please cite this article as: Khandan M, Koohpaei A, Shahbazi M, Allahdadi Z, Abdi Zarin S. Assessment of Individual and Occupational Risk Factors of Musculoskeletal Disorders Using BPAI among Dentists in Qom, Iran. Arch Hyg Sci 2020;9(3):234-245

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
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 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.
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 1st, 3rd, and 5th 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%
Musculoskeletal Disorders Assessment Using BPAI among Dentists

Khandan M et al. / Arch Hyg Sci 2020;9(3):234-245

Table 1) Branson’s posture assessment instrument worksheet

| Posture | Time | Acceptable | Compromised | Harmful |
|---------|------|------------|-------------|---------|
|         |      | 1 point    | 2 points    | 3 points |
| Hips    |      | Level on stool | Hips not level on stool |         |
|         |      | Front to back ≤20° | Front to back >20°, <45° | Front to back ≥45° |
|         |      | Side to side ≤20° | Side to side >20°, <45° | Side to side ≥45° |
|         |      | Rotation between planes ≤20° | Rotation between planes >20°, <45° | Rotation between planes ≥45° |
| Trunk   |      | Front to back ≤20° | Front to back >20°, <45° | Front to back ≥45° |
|         |      | Side to side ≤20° | Side to side >20°, <45° | Side to side ≥45° |
|         |      | Rotation between planes ≤20° | Rotation between planes >20°, <45° | Rotation between planes ≥45° |
| Head / Neck | | Front to back ≤20° | Front to back >20°, <45° | Front to back ≥45° |
|           |      | Side to side ≤20° | Side to side >20°, <45° | Side to side ≥45° |
|           |      | Rotation between planes ≤20° | Rotation between planes >20°, <45° | Rotation between planes ≥45° |
| Shoulders |      | Relaxed | Slumped forward | One or both shoulder elevated above line of trunk |
| Wrist    |      | Flexion or extension ≤15° (either wrist) | Flexion or extension >15° (either wrist) | |

Total Points

Table 2) Demographic characteristics of study population (n=51)

| Demographic Characteristics | Mean   | Standard deviation | Minimum | Maximum |
|-----------------------------|--------|--------------------|---------|---------|
| Age                         | 40.06  | 9.53               | 25      | 64      |
| Work experience (years)     | 13.37  | 8.93               | 1       | 41      |
| Work hours (weeks)          | 45.89  | 20.87              | 6       | 100     |
| Stress                      | 4.45   | 2.67               | 0       | 10      |
| Breaks during work (minutes)| 6.18   | 6.75               | 0       | 30      |

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

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 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.

It was also revealed that 21.6% and 78.4%
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 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 percentage of musculoskeletal disorders among dentists in the last year (n=51)

| Body region | Side | Frequency | Percentage |
|-------------|------|-----------|------------|
| Neck        | -    | 32        | 72.7       |
| Shoulder    | Right| 24        | 54.5       |
|             | Left | 17        | 38.6       |
| Back        | Upper| 20        | 45.5       |
|             | Lower| 15        | 34.1       |
| Arm         | Right| 7         | 15.9       |
|             | Left | 3         | 6.8        |
| Forearm     | Right| 4         | 9.1        |
|             | Left | 7         | 15.9       |
| Hip         | -    | 4         | 9.1        |

| Body region | Side | Frequency | Percentage |
|-------------|------|-----------|------------|
| Neck        | -    | 32        | 72.7       |
| Shoulder    | Right| 24        | 54.5       |
|             | Left | 17        | 38.6       |
| Back        | Upper| 20        | 45.5       |
|             | Lower| 15        | 34.1       |
| Arm         | Right| 7         | 15.9       |
|             | Left | 3         | 6.8        |
| Forearm     | Right| 4         | 9.1        |
|             | Left | 7         | 15.9       |
| Hip         | -    | 4         | 9.1        |

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

| BPAI level    | Gender  | Musculoskeletal disorder | Training on correct occupational posture |
|---------------|---------|--------------------------|------------------------------------------|
|               | Male    | Female                   | Yes | No   | Male    | Female | Yes | No   |
| Acceptable    | 9 (21.4)| 2 (22.2)                 | 9 (22)| 2 (22.2) | 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
Table 5) Frequency of Branson’s posture assessment instrument score in terms of different organs

| Body region/Posture                  | Score | 3  | 4  | 5  | 6  | 7  | 8  | 9  |
|--------------------------------------|-------|----|----|----|----|----|----|----|
| Leg                                  |       | 88.2 | 2  | -  | 9.8| -  | -  | -  |
| Thighs flat/non-flat on chair        |       | 47.1 | 11.8| 19.6| 17.6| 2  | -  | 2  |
| Forward or backward bending          |       | 70.6 | 15.7| 7.8 | 5.9 | -  | -  | -  |
| Lateral bending                      |       | 39.2 | 19.6| 21.6| 13.7| 3.9| -  | 2  |
| Waist                                |       |     |    |    |    |    |    |    |
| Forward or backward bending          | 11.8  | 5.9 | 9.8 | 43.1 | 9.8 | 11.8 | 7.8 | 2  |
| 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  | -  |
| Head/Neck                            |       |     |    |    |    |    |    |    |
| Forward or backward bending          | 76    | 4  | 12 | 8  | -  | -  | -  | -  |
| Lateral bending                      | 31.4  | 11.8| 3.9 | 52.9 | -  | -  | -  | -  |
| Rotation between planes              | -     | 5.9 | 17.6| 76.5 | -  | -  | -  | -  |
| Shoulders                            |       |     |    |    |    |    |    |    |
| Normal or slumped forward            | 45.67 | 4.35| 37 | 54  |    |    |    |    |
| Level with trunk/elevated above line of trunk | 42.14 | 8.17| 32 | 56  |    |    |    |    |
| Wrist                                |       |     |    |    |    |    |    |    |
| Flexion/extension                    | -     | 5.9 | 17.6| 76.5 | -  | -  | -  | -  |

Table 6) Stress and Branson’s posture assessment instrument scores in different dentistry tasks

| Task                                | Factor | Stress | BPAI Score |
|-------------------------------------|--------|--------|------------|
|                                     | 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

A significant 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
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±9.9), followed by maxillofacial neurosurgery (47.5±4.68) and mandibular fracture repair (45.67±4.36), respectively. On the other hand, orthodontics (37.5±9.2) and dental molding (40.67±3.46) had the lowest scores.

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 ≥ 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 ≥ 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

**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,
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±3.51) 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 processes, 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.

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

Acknowledgements

The authors thanks deeply to all dentists participated in the present study.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Bhandari SB, Bhandari R, Uppal RS, Grover D. Musculoskeletal disorders in clinical dentistry and their prevention. J Orofacial ResJOFR 2013; 3(2):106-14. Link
2. Branson BG, Williams KB, Bray KK, Mcllnay SL, Dickey D. Validity and reliability of a dental operator posture assessment instrument (PAI). J Dent Hyg. 2002;76(4):255-61. PMID: 12592916 Link
3. Mohammadi, Zeidi I, Heydarnia A, Niknami S, Safari A, Varmazyr S. The effects of an educational intervention on knowledge, attitude and ergonomic behaviors. Journal of Qazvin University of Medical Sciences 2010;14,(1)(54):33-40. (In Persian) Link
4. Iordache C, Fatu AM, Ignat R, Pomârleau C, Chirieac R, Anucia C. Musculoskeletal complaints
among dentists: focus on cervical spine involvement. Romanian Journal of Oral Rehabilitation 2016;8(4):5-11. Link

5. Seifi S, Eftekharian S, Sarrafan N, Gholina H. Ergonomic evaluation of frequency and risk factors of musculoskeletal disorder of specialist dentists of Babol dentistry faculty. J Urmia Univ Med Sci 2016;27(4):330-5. (In Persian) Link

6. Gharekhani S, Tirgar A, Seyyed M, Gholina H. An intervensional ergonomics program assessment of dental students. Biosci. Biotech. Res. Comm. 2016;9(4):814-20. Link

7. Ng A, Hayes MJ, Polster A. Musculoskeletal disorders and working posture among dental and oral health students. Healthcare 2016;4(13):1-153. PMID: 27417601 Link

8. Choobineh A R, Soleimani E, Daneshmandi H, Mohamadbeigi A, Izadi K. Prevalence of musculoskeletal disorders and posture analysis using RULA method in Shiraz general dentists in 2010. Journal of Islamic Dental Association of Iran (JIDA) 2013;25(1):35-40. Persinan( Link

9. Phedy P, Gatam L. Prevalence and associated factors of musculoskeletal disorders of young students in Indonesia. Malaysian Orthopaedic Journal 2016; 10(2):1-5. PMID: 28435553 Link

10. Rundcrantz BI, Johanson B, Morritz B. Pain and discomfort in the musculoskeletal system among dentists. A prospective study. Swed Dent J 1991; 15(5):219-28. PMID: 18373891 Link

11. Rundcrantz BI. Pain and discomfort in the musculoskeletal system among dentists. A prospective study. Swed Dent J Suppl 1991;76:1-102. PMID: 18301744 Link

12. Gupta A, Bhat M, Mohammed T, Bansal Na, Gupta G. Ergonomics in dentistry. International Journal of Clinical Pediatric Dentistry 2014;7(1):30-34. PMID: 25206234 Link

13. Pope-Ford R. A quantitative assessment of low back pain in dentistry. Procedia Manufacturing 2015; 3:4761-68. Link

14. Chaiklieng S, Suggaravetsiri P. Ergonomics risk and neck shoulder back pain among dental professionals. Procedia Manufacturing 2015;3:4900-905. Link

15. Khan SA, Chew KY. Effect of working characteristics and taught ergonomics on the prevalence of musculoskeletal disorders amongst dental students. BMC Musculoskeletal Disorders 2013;14:118-25. PMID: 23547959 Link

16. Petromilli Nordi Sasso Garcia PP, Pinelli C, dos Reis Derceli J, Alwares Duarte Bonini Campos JA. Musculoskeletal disorders in upper limbs in dental students: exposure level to risk factors. Braz J Oral Sci. 2012;11(2):148-4353. Link

17. Hayes MJ, Cockrell D, Smith DR, Cockrell D. A systematic review of musculoskeletal disorders among dental professionals. Int J Dent Hyg 2009; 7(3):159-165. PMID: 19659711 Link

18. Sartorio F, Vercelli S, Ferriero G, D’Angelo F, Migliario M, Franchignoni M. Work-related musculoskeletal diseases in dental professionals: 1-prevalence and risk factors. G Ital Med Lav Ergon 2005; 27(2): 165-169. PMID: 16124525 Link

19. Hayes MJ, Smith DR, Cockrell D. Prevalence and correlates of musculoskeletal disorders among Australian dental hygiene students. Int J Dent Hyg 2009;7(3):176-181. PMID: 19659713 Link

20. Zoidaki A, Riza E, Kastania A, Papadimitriou E, Linos A. Musculoskeletal disorders among dentists in the Greater Athens area, Greece: risk factors and correlations. J Public Health. 2013; 21(2): 163–173. Link

21. Barghout NH, Al-Habashneh R, Al-Omri MK. Risk factors and prevalence of musculoskeletal disorders among Jordanian dentists. Jordan Medical Journal. 2011; 45171(779): 195-204. Link

22. Rafie F, Zamani Jam A, Shahrvan A, Raoof M, Eskandarizadeh A. Prevalence of upper extremity musculoskeletal disorders in dentists: symptoms and risk factors. J Environ Public Health. 2015; 2015: 517346. PMID: 26064141 Link

23. Ohlendorf D, Erbe C, Hauck I, Nowak J, Hermans I, Ditchen D, et al. Kinematic analysis of work-related musculoskeletal loading of trunk among dentists in Germany. BMC Musculoskeletal Disord. 2016; 17(1): 427. PMID: 27756271 Link

24. Askaripoor T, Kermani A, Jandaghi J, Farivar F. Survey of musculoskeletal disorders and ergonomic risk factors among dentists and providing control measures in Semnan. J Health J ArdabilHgy 2013; 4(3):241-4. Link

25. Yaghobee S, Esmaeili V. Evaluation of the effect of the ergonomic principles’ instructions on the dental students’ postures and an ergonomic assessment. J Dent Med 2010;23(2):121-7. Esmaeili V. Evaluation of the effect of the ergonomic principles instructions on the dental students’ postures; an ergonomic assessment. Journal of Dental Medicine. 2010;23: 121-127. Link

26. Abdulalizadeh M, Jahanmoghadam F. Musculoskeletal disorders in dental practitioners and ergonomic strategies. Anatomical Sciences 2015; 12(4):161-6. Link

27. Marklin RW, Cherney K. Working postures of dentists and dental hygienists. Journal of the California Dental Association 2005;33(2):133-6. PMID: 15816703 Link

28. Shrestha BP, Singh GK, Niraula SR. Work related complaints among dentists. J Nepal Med Assoc. 2008;47(170):77-81. PMID: 18709036 Link

29. Alexopoulos EC, Stathi IC, Charizani F. Prevalence
of musculoskeletal disorders in dentists. BMC Musculoskeletal Disorders 2004;5(1):16-23. PMID: 15189564 Link
30. Rabiei M, Shakiba M, Dehghan Shirreza H, Talebzadeh M. Musculoskeletal disorders in dentists. Int J Occup Hyg 2012;4(1):36-40. Link
31. Petromilli Nordi Sasso Garcia P, Scatimburgo Polli GS, Alvarees Duarte Bonini Campos JA. Working postures of dental students: ergonomic analysis using the Ovako working analysis system and rapid upper limb assessment. Med Lav 2013;104(6):440-447. PMID: 24640831 Link
32. Gandavadi A, Ramsay JRE, Burke FJT. Assessment of dental student posture in two seating conditions using RULA methodology - A a pilot study. British Dental Journal 2007;203(710):601-5. PMID: 18037853 Link
33. Koshy JM, Archana R, Markose B, Johnson WMS, Narayanans S, Sathyappa Priya B. Evaluation of working posture among the dentist using rula and reba. International Journal of Current Research 2017;9(12):63316-20. Link
34. Park HS, Kim J, Roh HL, Namkoong S. Analysis of the risk factors of musculoskeletal disease among dentists induced by work posture. J. Phys. Ther. Sci. 2015;27(12):3651-5. PMID: 26834324 Link
35. Rahamayee Tamrooiy FR, Akbari Javar MA, Salimi S, Mohammadpour H, Avakh A, Faizollahi S. A survey on prevalence of musculoskeletal disorders in dentists of Tehran and their posture assessment by RULA method. Intl. Res. J. Appl. Basic. Sci. 2015;9(5):666-71. Link
36. Branson BG, Black MA, Simmer-Beck M. Changes in posture: A a case study of a dental hygiene's use of magnification loupes. Work 2010;35(4):467-76. PMID: 20448325Link
37. Chamani G, Zarei MR, Momennazadeh A, Safizadeh H, Rad M, Alayari A. Prevalence of musculoskeletal disorders among dentists in Kerman, Iran. Journal of Musculoskeletal Pain. 2012;20(3):202-7. Link
38. Feiz A, Habibi E, Hekmatian E, Gholami M, Ahmad N, Mohebian Z. Evaluation of ergonomic errors of body postures in senior undergraduate and postgraduate students in Isfahan Dental School in 2014-2015 using Rapid Entire Body Assessment (REBA) Method. J Isfahan Dent Sch 2016;12(1):9-18. (In Persian) ( Link
39. Abdol Samat RA, Shafei MN, Yaacob NA, Yusoff A. Prevalence and associated factors of back pain among dental personnel in north-eastern state of Malaysia. International Journal of Collaborative Research on Internal Medicine & Public Health 2011;3(7):576-86. Link
40. Abduljabbar TA. Musculoskeletal disorders among dentists in Saudi Arabia. Pakistan Oral & Dental Journal 2008;28(1):135-144. Link
41. Alghadir A, Zafar H, Iqbal ZA. Work-related musculoskeletal disorders among dental professionals in Saudi Arabia. J Phys Ther Sci 2015;27(4):1107-12Senthil P, Kumar V, Baliga M. Work-related musculoskeletal disorders among dental professionals: An evidence-based update. Indian Journal of Dental Education 2012;5(1):5-12. PMID: 25995567 Link
42. Madaan V, Chudhari A. Prevalence and risk factor associated with musculoskeletal pain among students of MGM dental college: A a cross sectional survey. J Contemp Dent 2012;2(2):22-27. Link
43. Jahanimoghadam F, Horri A, Hasheminejad N, Nejad NH, Baneshi MR. Ergonomic evaluation of dental professionals as determined by rapid entire body assessment method in 2014. J Dent 2018;19(2):155 Jahanimoghadam F, Horri A, Hasheminejad N, Hashemi Nejad N, Baneshi MR. Ergonomic evaluation of dental professionals as determined by Rapid Entire Body Assessment method in 2014. J Dent Shiraz Univ Med Sci. 2018;19(2):155-8. PMID: 29854890 (Persian) Link
44. Shirzaei M, Mirzaei R, Khaje-Alizade A, Mohammadi M. Evaluation of ergonomic factors and postures that cause muscle pains in dentistry students' bodies. J Clin Exp Dent. 2015;7(3):414-8. PMID: 26330941 Link
45. Wajngarten D, Garcia PP. The use of magnification and work posture in dentistry--a literature review. J Adv Med Med Res 2016;5:1-9Petromilli Nordi Sasso Garcia P, Wajngarten D. The use of magnification and work posture in dentistry - A literature review. BIMMR 2016;18(8):1-9. Link
46. Mehrdad R, Shams-Hosseini NS, Aghdai S, Yousefian M. Prevalence of low back pain in health care workers and comparison with other occupational categories in Iran: A a systematic review. Iran J Med Sci 2016;41(6):467-78. PMID: 27853326Link
47. Rempel D, Azevedo S, Raider F. Dental hygiene work: Pain is NOT in the job description. CDHA Journal 2015;33(2):2-108. Link
48. Pejčić N, Đurić Jovičić M, Miljković N, Popović DB, Petrović V. Posture in dentists: Sitting vs. standing positions during dentistry work - An EMG study. Srp Arh Celok. Lek. 2016;144 ((3-4):181-187. PMID: 27483563Link
49. Dupim Presoto CD, Garcia PP. Risk factors for the development of musculoskeletal disorders in dental work. J Educ Soc Behav Sci 2016Presoto C, Petromilli Nordi Sasso Patricia G. Risk factors for the development of musculoskeletal disorders in dental work. BJESBS 2016;15(4):1-6. Link
50. Saleh M, Miko H, Triyanto R, Artawa IMB. Musculoskeletal disorders and cumulative trauma
disorders in dental practitioner (review article: risk factor in dentist and dental hygienists). Actual Research Science Academic 2016;1(1):1-10. Link
51. Johnson CR, Kanji Z. The impact of occupation-related musculoskeletal disorders on dental hygienists. Can J Dent Hyg 2016;50(2):72-79. Link
52. Koohpaei A, Khandan M, Vosoughi S, Khammar A, Mobinizade V, Farrokhi M, Poursadeghiyan Met al. Industrial workers' postures analysis by a new method named “loading on the upper body assessment” in Iran. Ann Trop Med Public Health 2017;10(4):973-7. Link