



Prevalence and Characterization of Musculoskeletal Disorders among Dental Students, Interns, and Residents in Riyadh, Saudi Arabia

Abdulmajeed Alrumi¹✉, Abdullah Alsheraimi¹, Saleh Alassaf¹, Abdulmajeed Alharbi¹, Abdulrahman Alenezi¹, Abdullah Almajed¹, Nawaf Alshetan¹, Khaled Alomairiy¹, Rima Safadi⁴, Ali Aboalela^{1,2,3}

¹College of Dentistry, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

²King Abdullah International Medical Research Centre, Riyadh, Saudi Arabia

³National Guard Health Affairs, Riyadh, Saudi Arabia

⁴Jordan University of Science and Technology, Jordan

✉Corresponding author:

Abdulmajeed Abdulaziz Alrumi; College of Dentistry,

King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia, E-mail: abdulmajeedalrumi@hotmail.com

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ABSTRACT

Objectives: This study aimed to investigate the prevalence of work-related musculoskeletal disorders, assess its impact, identify its risk factors, level of awareness of the participants, and to recommend preventive measures based on the study results. **Methods:** A self-structured self-administered questionnaire consists of 48 questions was distributed to participants from dental colleges at three universities (King Saud University, King Saud bin Abdulaziz University for health sciences, and Riyadh Elm university). A total of (431) participants were invited to answer the questionnaire. Chi-Squared test was performed to evaluate the influence of demographic characteristics (gender and level of education), the prevalence of musculoskeletal pain, and psychological impact. **Results:** There was a significant difference between genders regarding pain, in which (53%) of females reported having pain, while only (35%) of males did. Periodontal scaling was the most reported cause of pain (51.8%). The psychological effect of pain was significantly higher in females (25%), while it was (12%) in males. Chairside stretching has a significant impact on reducing the presence of pain. **Conclusion:** The prevalence of work-related musculoskeletal disorders in the dental field is high. In this study, females have a higher percentage of pain. Pain has a negative effect on a person's psychology. The use of magnification loupes and chairside stretching was found to be a protective factor against musculoskeletal disorders.

Keywords: Musculoskeletal disorders, Work-related pain, and Dental students.

1. INTRODUCTION

Musculoskeletal disorders are soft-tissue injuries caused by sudden or sustained exposure to repetitive motion, force, vibration, and awkward positions. These disorders can affect the muscles, nerves, tendons, joints, and cartilages in upper and lower limbs, neck, and lower back, as defined by The National Institute for Occupational Safety and Health (NIOSH & CDC, 2019). According to the International Classification of Diseases, musculoskeletal disorders are one of the listed diseases that compromise more than 150 diagnoses. Musculoskeletal disorders range from the sudden onset, short-lasting to lifelong conditions.

Musculoskeletal disorders most generally affect adolescence through to older age people. The impact and prevalence of musculoskeletal conditions are anticipated to rise as the global population ages. Most of the studies in the subject of work-related hazards among dental professionals were conducted in multiple developed countries; the results of these studies suggest a higher prevalence of musculoskeletal disorders among the dental profession (Leggat et al, 2007; Sakzewski & Naser, 2014; Leggat & Smith, 2006).

Dentistry is a unique profession in terms of work factors and health risks. Dentists are required to use their bodies excessively to perform their work in an ideal way (Graham, 2002). Numerous parts of the body, involving the neck, back, and wrist can be negatively affected if the dentist is not seated comfortably in the correct posture. The adverse effects include fatigue, strain, and pain in the muscles, eventually leading to symptoms in the musculoskeletal system (McNee et al, 2013; Kierklo et al, 2011). Musculoskeletal disorders are the most common cause of early retirement among dentists. Musculoskeletal disorders (29.5%) have the highest percentage of the reason for retirement and resignation following (21.2%) neurotic symptoms (16.5%), tumors (7.6%), and lastly, diseases of the nervous system (6.1%) (Gupta et al, 2014). Musculoskeletal disorders lead to work impairment, disability, compensation costs, and loss of productivity, which necessitates the need for interception and the correction of the working environment ergonomics need to be delivered to students and practitioners.

In a study that was published in Environmental Science and Pollution Research journal in 2017, (39%) knew the concept of ergonomics, and most dental students (83.3%) knew the best posture of the dentist sitting. Nearly two-thirds of the students (64.3%) knew the points on the body that come in contact with patients and objects for stable control and sightings of the operating points. Almost two-thirds of the participants which were students (69.1%) think that ergonomics should definitely be a part of their curriculum (Ísper Garbin et al, 2017). Few studies have been conducted in Saudi Arabia on this issue and were mostly focused on dentists (Alghadir, 2015; Al Wazzan, 2001). Therefore, this study is aimed to explore the prevalence of work-related musculoskeletal disorders among dental students, interns, and residents in Riyadh, Saudi Arabia, and to assess the level of awareness regarding ergonomics and right postural conditions.

2. MATERIALS AND METHODS

The present study is a cross-sectional, analytical study conducted to assess the prevalence and characterization of musculoskeletal disorders among dental students, interns, and residents in Riyadh, Saudi Arabia. The research was reviewed and approved under reference #SP19/533/R from the Institutional Review Board (IRB) of the King Abdullah International Medical Research Center (KAIMRC) prior to the commencement of the study. Written and oral informed consent was obtained from all individual participants included in the study. This research received no external funding. Data were collected from dental students, interns, and residents from King Saud University, King Saud bin Abdulaziz University for health sciences, and Riyadh Elm University in Riyadh, Saudi Arabia from September until October 2019.

A convenient sampling technique was used to draw a sample from all dental students, interns, and residents from selected dental colleges, in which they perform in clinics. Data were collected from 431 participants who fulfilled the study's criteria. Inclusion criteria were dental students, interns, and residents in various dental specialties in the previously identified universities. Exclusion criteria were a history of previous accidents that might have contributed to work-related pain, physically challenged participants. Also, students in the pre-professional stage that have been assigned to the college of dentistry are excluded. Each participant read and signed the consent form before filling the questionnaire.

The literature review was done to identify significant questions and areas of interest. A self-structured self-administered questionnaire was given to participants to assess the risk factors, the prevalence of musculoskeletal symptoms, and the level of awareness. The authors declare that they have no conflict of interest. A total of 48 questions were included in the questionnaire, which was divided into four main parts: (1) demographic variables (2) work characteristics (3) prevalence of musculoskeletal symptoms (4) the level of awareness. The validation process of the self-structured questionnaire went through two phases. The first phase was a panel discussion with five dentists who are experts in dental research. The second phase was piloting the survey with a group of 16 dental students.

The participants found the questionnaires to be detailed and easy to follow. Two methods were used to distribute the survey. First, paper-based were distributed during clinical sessions and were collected the same day after a few hours. The online-based questionnaire was distributed using social media and communication applications through Google Forms. Data were analyzed by the SPSS statistical software version 23. Frequency distribution of the different demographic characteristics (e.g., age, gender, level of education), the presence of pain and character, work variables (e.g., nature of the procedure, number of operation per clinical session, use of magnification devices), and the level of awareness regarding ergonomics (e.g., correct body posture) were analyzed.

Chi-square tests were used to calculate the statistical difference of these variables. Results with a p-value of equal or less than a level of 0.05 were considered significant. In order to determine the association of musculoskeletal symptoms with variables, a Chi-Squared test was performed to evaluate the influence of demographic characteristics (gender and level of education), the prevalence of musculoskeletal pain, and psychological impact.

3. RESULTS

Two hundred fifty-nine males and one hundred seventy-two females have filled a total number of 431 questionnaires. The study divided the participants according to their level of educations from first-year dental students up to residents. The highest percentage was interns (27.8%), followed by senior dental students (23.8%). The specialty with the most participated residents was orthodontics (25.4%), followed by endodontics (23.6%), pediatric dentistry (21.8%), and operative dentistry (16.3%). Work-related pain was reported in (42.9%) of all participants.

There was a significant difference between genders, in which (53%) of females reported the presence of pain. On the other hand, (35%) of males had pain ($p < 0.001$). The pain was intermittent while working and through the procedures in (76%) of cases. The most commonly affected body regions were the back (70.2%), the neck (57.6%), and the shoulders (55.6%). Females had significantly higher pain ($p < 0.001$) in the shoulders (34%) compared to males (15%). Neck pain was also significantly higher in females (32%) in comparison to males, in which (17%) had neck pain ($p = 0.01$).

Table 1 Demographics and Presence of Pain

| Observed parameters | | Count | Presence of pain | | Statistically significant |
|---------------------|--------|-------|------------------|-------------|---------------------------|
| | | | Yes (n= 185) | No (n= 246) | |
| Gender | Male | 259 | 93(35.9%) | 166 (64.1) | P<0.001 |
| | Female | 172 | 92(53%) | 80 (47%) | |

| | | | | | |
|--------------------|----------|-----|------------|------------|---------|
| Level of education | D1 | 26 | 4(15.4%) | 22(84.6%) | P=0.009 |
| | D2 | 62 | 22(35.5%) | 40(64.5%) | |
| | D3 | 65 | 33(50.8%) | 32(49.2%) | |
| | D4 | 103 | 46(44.7%) | 57(55.3%) | |
| | Intern | 120 | 49(40.8%) | 71(59.2%) | |
| | Resident | 55 | 31(56.4%) | 24(43.6%) | |
| Dominant hand | Right | 389 | 169(43.4%) | 220(56.5%) | P=0.273 |
| | Left | 42 | 16(38.1%) | 26(61.9%) | |

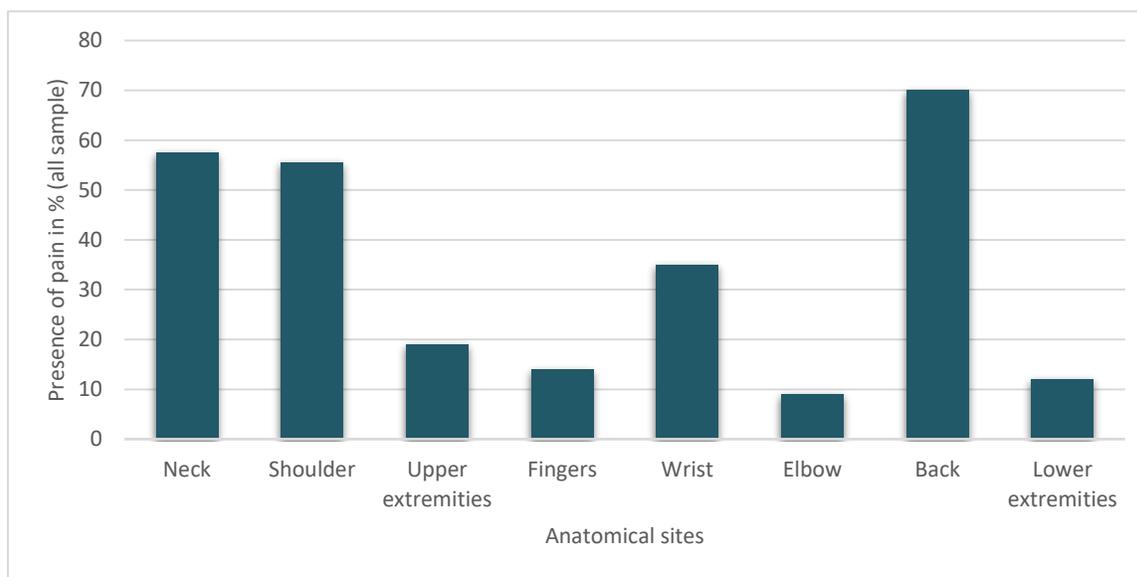


Figure 1 Presence of pain in different anatomical sites

Periodontal scaling was the most reported cause of pain (51.8%), and endodontic treatment was the second most reported cause (43.3%). On a scale from zero to ten in which zero means no pain and ten means unimaginable and unspeakable suffering, the most chosen pain rank was four. Only 8.3% considered seeking medical consultation. Around (15%) of participants who have pain consulted a physician. In those cases, the primary care physician was the most visited health professional for consultation (41.3%). Furthermore, a significantly higher number of females (12%) consulted a physician regarding their pain, whereas only (5.5%) of males did ($p=0.026$).

The participants who have pain due to work-related musculoskeletal disorders had reduced their productivity (17.8%), psychological effect (17.7%), reported being absent from work because of the pain (4%), and thought of changing their career because of work-related pain (8.6%). Participants thought of specializing in a non-operative dental specialty because of work-related pain (21.7%). Females reported a significantly higher reduction of productivity due to pain, which was (21%) compared to (15.5%) of males ($p=0.02$). The psychological effect of pain was significantly higher in females (25%) than in males (12%) ($p=0.002$). Analgesics were reported to be used to relieve the pain (19.4%), and paracetamol was the most commonly used medication in the sample study (54%).

Optical devices are used by (19.2%) of participants, and the dental loupes and microscope were used in equal percentages. Chairside stretching is exercised as a preventive measure by the participants (49.8%). Regarding patient positioning, the supine position is used the most (65.8%), followed by semi-supine (31.3%). Working while sitting was the most used seating position (72%), followed by alternating between sitting and standing (24%). Concerning patient comfort, participants who believed that the patient's comfort was more important than theirs were (54.4%). Half of the participants stated they stay static for more than 30 minutes in their regular practice (51%). A clinical session was defined in the questionnaire as a three hours session. The majority of the participants had an average of one to two procedures per clinical session (76%).

Chairside stretching was a significant preventive measure that caused a considerable difference regarding the presence of pain ($p=0.009$). Moreover, the position of the arms while working as a substantial factor ($p=0.01$), in which participants who did not have pain, had their arms close to their bodies during the work (80%). Most participants stated being aware of the correct body posture

(92.1%), and (94.2%) said being aware that the improper body posture can lead to MSD. Ergonomics were taught through lectures (87.4%), but only (12.5%) stated they had more than seven lectures.

4. DISCUSSION

The present self-administered survey was designed to investigate the prevalence and characterization of musculoskeletal disorders among dental students, interns, and residents in Riyadh, Saudi Arabia, and to recommend possible solutions to decrease and lower the prevalence of musculoskeletal disorders in the future of the coming dentists. The provided self-reported information by the participants was of clinical significance for the assessment of occupational health hazards among dental students and professionals at different educational levels.

There was a significant difference in pain between the demographic variables of the participants. In this study, female participants reported pain (53.4%), whereas only (35.9%) of male participants reported pain ($p < 0.001$). Most studies in the literature regarding this topic support these findings (Ísper Garbin et al, 2017; Aghilinejad et al, 2016; Dehghan et al, 2016).

According to a study done by Khan et al, within the cohort of 410 clinical students, (72%) of female students reported symptoms of pain, while it was only (20%) of male students (Khan & Yee Chew, 2013). This may suggest reasons or risk factors for female predominance for musculoskeletal disorders. Also, the difference in pain may be due to biological differences (such as muscular capacity, aerobic capacity, and hormonal conditions), as well as psychological differences such as coping strategies (Presoto et al, 2018).

The pain gradually increased with significant differences concerning the level of education from first-year students to interns ($p = 0.009$). This may be since students get more physical activity being held and clinical work as the participants move from a level to a higher one. These results were similar to other studies (Rajeswari et al, 2016; YI et al, 2013). On the contrary, another study found that there was no association between different academic levels (Presoto et al, 2018). Regarding the residents, they had contradictory results that need further investigations.

Most of the instructions of ergonomics and procedures are introduced to right-handed students and practitioners. It was one of the essential assessments to discover if left-handed students and practitioners perform more awkward positions. Unfortunately, there was not enough valid literature concerning this issue. In this study, there was no statistically significant difference regarding the dominant hand of the individual ($p = 0.273$). It could be due to the low number of left-handed participants in the provided study; further investigation may be needed to evaluate if there is an apparent difference.

The prevalence and distribution of work-related musculoskeletal disorders signs and symptoms were observed in this study, and the most commonly affected body regions were the back (70.2%), the neck (57.6%), and the shoulder (55.6%). Aljankh et al. (2015) had the same order in his study, and he stated that the most commonly affected areas are the lower back (73.5%), followed by the neck (66%) and the shoulders (43.3%) (Aljankh et al, 2015). However, the neck had higher signs and symptoms in another study (Koni et al, 2018).

In this study, females had significantly higher pain ($p < 0.001$) in the shoulder (34%) compared to males (15%). Besides, neck pain was also significantly higher in females (32%) in comparison with males (17%) ($p = 0.01$). In a different study, they found that there are site-specific symptoms with gender, while neck pain is more in females, and back pain is more in males (Kumar et al, 2013). Unfortunately, there is a lack of substantial evidence in the literature regarding the reasons behind gender and pain specificity in certain regions.

Participants reported in the provided study that their pain was not continuous but intermittent in (76%) of the cases. According to Pejčić et al. (2017), the worst pain was during work, then during a work break, and lastly, after a work time. (Pejčić et al, 2017). Pain is the result of causative factors that exist during the clinical operation, so once the dental procedure is done, the pain discontinues. In other cases, where pain continues after the dental practice, pain is a consequence of the accumulative effect of risk factors that the practitioner deals with regularly. Further investigations should be addressed to clarify the specific risk factors and the cumulative impact of pain regarding musculoskeletal disorders.

Scaling and root planning appear to be a simple procedure, but the operator must change his or her position and patient position during treatment to achieve optimum results. Periodontal scaling and root planning were the most reported cause of pain (51.8%), and endodontic treatment was the second most reported cause (43.3%). In the provided study, the results were not high enough to indicate a significant difference in pain with different specialties in dentistry ($p = 0.398$). YI, J et al. (2013) stated that residents in the department of periodontics reported the highest prevalence of pain, while prosthodontic students reported the lowest even though there was no statistical difference between the different specialties regarding pain (YI et al, 2013).

In dentistry, visibility and illumination are of paramount importance for the clinical judgment and success of various dental procedures (James and Gilmour, 2010). Dental magnifying loupes are developed and used to enhance the visual ability of the dental

operator and provide better illumination for the dental operative field (James and Gilmour, 2010). In this study, the majority of male and female dental students, interns, and residents in different specialties who use optical devices had significantly less pain than those who did not ($p=0.012$). In a systematic review (2018), it has been shown that dental magnifying loupes led to improved working postures up to 78%, and their usage appears to relieve shoulder, arm, and hand pain (Plessas and Bernardes Delgado, 2018). Additionally, Aghilinejad et al. (2016) stated in his study, the usage of magnification dental loupes was a significant factor in the reduction of discomfort intensity and (96%) of dentists believed that the use of dental loupes facilitated their work (Aghilinejad et al, 2016). Magnification devices, such as dental loupes or microscope, may aid and help the body posture and movements and prevent excessive bending of the neck and back.

According to Gupta et al. (2014), it is recommended that hands and fingers are kept above 25°C or 77°F to avoid detrimental effects on dexterity and grip strength (Gupta et al,2014).In the presented study, the results of the dental clinic room temperature were not indicating a statistical difference regarding pain ($p=0.06$).

Kierklo et al. (2011) reported that prophylactic physical activity influenced the occurrence of musculoskeletal disorders (Kierklo et al, 2011). Also, Koni et al. (2018), stated that (49%) of students reported an improvement in pain symptoms three months after the training (Koni et al, 2018). These results indicated a relation between physical activity and exercise with musculoskeletal disorders. Stretching, which is considered as physical activity, keeps the muscles flexible, durable, and healthy. Flexibility helps maintain a range of motion in the joints (Harvard Health Publishing, 2020). In the provided study, pain prevalence concerning practitioners who perform chairside stretching was significantly lower in both males and females, which were (61.4%) of participants who regularly did stretching throughout the clinical session ($p=0.035$). Chairside stretching seems to be an essential strategy to perform throughout the workday to prevent muscle fatigue. Further clinical trial studies to establish high-quality evidence between chairside stretching and reduction of musculoskeletal pain are needed.

Lack of support increases the static load on the upper and lower back muscles required to maintain the working position. 80% of people who did not have pain had their arms closer to their bodies while working ($p=0.001$). El-Sallamy, et al. (2017) stated that (24.2%) of students always orient the operating field to the elbow level of the working hand, and only (8.6%) of the participants made an effort to maintain neutral posture while working (El-Sallamy et al, 2017). Holding proper arm and body positions is a critical issue that needs further commitment from the practitioner to limit and decrease the effects of musculoskeletal pain.

It has been assumed that the size of gloves could be a potential cause of pain (Gupta et al, 2014). In this study, there is no apparent difference between glove sizes with pain ($p=0.6$). That is simply because most participants used well-fitted gloves that enabled them to move their hands and fingers freely without limitations.

Dental practitioners, whose working hours exceed seven per day, were significantly associated with increased risk of developing wrist pain, which may have a negative impact on the overall productivity (Al-Hourani et al, 2017). In the presented framework of this study, a question was implemented to seek information regarding the productivity status, and its results indicated that (21%) of females and (15.5%) of males thought that pain would reduce their work productivity ($p=0.022$).

In a question that was based on a subjective manner, the participants were asked whether they ever thought of choosing a dental specialty which does not require clinical or operative work. Almost a third of the participants in this study (27.9%) who had pain wanted to select a non-operative dental specialty. Although it was based on a subjective manner and each person is different, it is a possible solution and alternative for dentists who prefer to continue in the profession but not deal with the clinical work.

It has been shown that women perceive more pain than men, and this has been demonstrated for clinical pain and experimental pain in humans and animals (Pieretti et al, 2016). Precise mechanisms causing the observed difference are not yet apparent, and it has been advocated that the interaction of biological, psychological, and socio-cultural factors probably contributes to these differences (Pieretti et al, 2016). In the presented study, Males did not have a negative psychological effect. On the contrary, (25%) of females stated that pain due to musculoskeletal disorders had a negative psychological impact on their lives ($p=0.002$).

Pejicic et al. (2017) stated that dentists used analgesics in (47.3%) of sample study, and they were looking for medical treatment in (39%) to combat the musculoskeletal disorder (Pejicic et al, 2017). In the provided research, the most commonly used one was paracetamol (85.3%). Even though the precise mechanism of action is not known for the drug, it is considered a safe drug and a good pain reliever. Females, in this study sample, had a significantly higher percentage of using analgesics ($p=0.003$). Vicente-Herrero et al. (2016) mentioned that NSAIDs and simple analgesics have higher rates of improvement in pain ($P=.032$ and $P<.0001$, respectively) (Vicente-Herrero et al, 2016). In general, these results might be considered a short-term solution to the current work-related musculoskeletal issue, which can help in an overall improvement in physical and psychological.

Most participants of this sample study (92.1%) stated that they are aware of the correct body posture, yet almost half of them (45.1%) still had pain and discomfort. On the contrary, Shirzaei A. et al. (2015) stated that 80.8% of the exposure group students were not aware of appropriate ergonomic postures for optimizing clinical activities (Shirzaei et al, 2015). Further investigations are

still needed concerning the reason behind their pain and discomfort. It is essential to find whether the information and method of education of proper ergonomics are adequate or not, and the application of those methods during the clinical session. Considering the literature and the results of this provided study, the Introduction of an ergonomic course to dental students in their pre-clinical years would be beneficial and helpful. It must contain a practical part as well as a didactical part to make sure that the knowledge about the topic is well taught to students.

The students should know the benefits and risk factors of the career in terms of ergonomics. It is reported that more than two-thirds of the students (69.1%) think that ergonomics should definitely be a part of their curriculum (El-sallamy et al, 2017). Another helping factor is that students should get introduced and acquainted with dental magnification devices and have a better awareness of the usage at their initial stages of their pre-clinical work. Also, proper monitoring of students in the open clinics at their undergrad stage should be implemented by various instructors in the field.

5. CONCLUSION

Work-related musculoskeletal disorders are more prevalent, especially in the dental field. Females face a higher percentage of pain in the dental area. The prevalence of pain was higher, with an advanced level of education. Work-related pain has an impact on both the person's clinical performance and psychology. Utilization of magnification devices, chairside stretching, and close position of arms can significantly reduce pain and discomfort. Awareness rates regarding protective factors against MSD are high among dental practitioners, yet a lot of them still suffer from it.

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REFERENCE

1. Cdc.gov. (2019). CDC - NIOSH Program Portfolio: Musculoskeletal Disorders: Program Description. [online] Available at: <https://www.cdc.gov/niosh/programs/msd/> [Accessed 25 Mar. 2019].
2. Leggat PA, Kedjarune U, Smith DR. Occupational health problems in modern dentistry: a review. *Ind Health*. 2007; 45:611–621.
3. Sakzewski L, Naser-ud-Din S. Work-related musculoskeletal disorders in dentists and orthodontists: a review of the literature. *Work*. 2014; 48:37–45.
4. Leggat PA, Smith DR. Musculoskeletal disorders self-reported by dentists in Queensland, Australia. *Aust Dent J*. 2006; 51:324–327.
5. Graham C. Ergonomics in dentistry, Part 1. *Dent Today*. 2002; 21:98–103.
6. McNee CI, Kieser JK, Antoun JS, Bennani H, Gallo LM, Farella M. Neck, and shoulder muscle activity of orthodontists in natural environments. *J Electromyogr Kinesiol*. 2013; 23:600–607.
7. Kierklo A1, Kobus A, Jaworska M, Botulinski B. Workrelated musculoskeletal disorders among dentists a questionnaire survey. *Ann Agric Environ Med*. 2011; 18:79–84.
8. Gupta A, Bhat M, Mohammed T, Bansal N, Gupta G. Ergonomics in Dentistry. *International Journal of Clinical Pediatric Dentistry*. 2014; 7:28-32
9. Ísper Garbin AJ, Barreto Soares G, Moreira Arcieri R, Adas Saliba Garbin C, Siqueira CE. Musculoskeletal disorders and perception of working conditions: A survey of Brazilian dentists in São Paulo. *Int J Occup Med Environ Health*. 2017;30(3):367-377.
10. Alghadir A, Zafar H, Iqbal ZA. Work-related musculoskeletal disorders among dental professionals in Saudi Arabia. *J Phys Ther Sci*. 2015; 27:1107–1112.
11. Al Wazzan KA, Almas K, Al Shethri SE, Al-Qahtani MQ. Back and neck problems among dentists and dental auxiliaries. *J Contemp Dent Pract*. 2001; 2:17–30.
12. Aghilinejad M, Kabir-mokamelkhah E, Talebi A, Soleimani R, Dehghan N. The effect of magnification lenses on reducing musculoskeletal discomfort among dentists. *Med J Islam Repub Iran*. 2016; 30:473

13. Dehghan N, Aghilinejad M, Nassiri-kashani MH, Amiri Z, Talebi A. The effect of a multifaceted ergonomic intervention program on reducing musculoskeletal disorders in dentists. *Med J Islam Repub Iran*. 2016; 30:472
14. Khan S, Yee Chew K. Effect of working characteristics and taught ergonomics on the prevalence of musculoskeletal disorders amongst dental students. *BMC Musculoskeletal Disorders*. 2013;14(1)
15. Presoto C, Wajngarten D, Domingos P, Campos J, Garcia P. Dental Students' Perceptions of Risk Factors for Musculoskeletal Disorders: Adapting the Job Factors Questionnaire for Dentistry. *Journal of Dental Education*. 2018;82(1):47-53.
16. Rajeswari S, Gowda T, Kumar T, Arya K, Mehta D. Assessment of interns and postgraduate dental student's knowledge regarding equipment ergonomics. *Indian Journal of Dental Research*. 2016;27(3):256.
17. Yi J, Hu X, Yan B, Zheng W, Li Y, Zhao Z. High, and specialty-related musculoskeletal disorders afflict dental professionals even since early training years. *Journal of Applied Oral Science*. 2013;21(4):376-382.
18. Aljanakh M, Shaikh S, Siddiqui A, Al-Mansour M, Hassan S. Prevalence of musculoskeletal disorders among dentists in the Ha'il Region of Saudi Arabia. *Annals of Saudi Medicine*. 2015;35(6):456-461.
19. Koni A, Kufersin M, Ronchese F, Travan M, Cadenaro M, Larese filon F. Approach to prevention of musculoskeletal symptoms in dental students: an interventional study. *Med Lav*. 2018;109(4):276-284
20. Kumar S, Baliga M, Kumar V. Prevalence of work-related musculoskeletal complaints among dentists in India: A national cross-sectional survey. *Indian Journal of Dental Research*. 2013;24(4):428.
21. Pejčić N, Petrović V, Marković D, Miličić B, Dimitrijević I, Perunović N et al. Assessment of risk factors and preventive measures and their relations to work-related musculoskeletal pain among dentists. *Work*. 2017;57(4):573-593.
22. James T, Gilmour A. Magnifying Loupes in Modern Dental Practice: An Update. *Dent Update*. 2010;37(9):633-636
23. Plessas A, Bernardes Delgado M. The role of ergonomic saddle seats and magnification loupes in the prevention of musculoskeletal disorders. A systematic review. *International Journal of Dental Hygiene*. 2018;16(4):430-440.
24. The importance of stretching - Harvard Health [Internet]. Harvard Health. 2020 [cited 8 February 2019]. Available from: <https://www.health.harvard.edu/staying-healthy/the-importance-of-stretching>
25. El-sallamy R, Atlam S, Kabbash I, El-fatah S, El-flaky A. Knowledge, attitude, and practice towards ergonomics among undergraduates of Faculty of Dentistry, Tanta University, Egypt. *Environmental Science and Pollution Research*. 2017;25(31):30793-30801.
26. Al-Hourani Z, Nazzal M, Khader Y, Almhdawi K, Bibars A. Work-related musculoskeletal disorders among Jordanian dental technicians: Prevalence and associated factors. *Work*. 2017;56(4):617-623.
27. Pieretti S, Di Giannuario A, Di Giovannandrea R, Marzoli F, Piccaro G, Minosi P et al. Gender differences in pain and its relief. *Ann Ist Super Sanita*. 2016: 184-189.
28. Vicente-Herrero M, López-González Á, Ramírez Iñiguez de la Torre M, Capdevila García L, Terradillos García M, Aguilar Jiménez E. Pain and Workplace. Sociodemographic Variables Influence in Therapeutic Response and Labor Productivity. 2016: 370-379.
29. Shirzaei M, Mirzaei R, Khaje-Alizade A, Mohammadi M. Evaluation of ergonomic factors and postures that cause muscle pains in dentistry students bodies. *Journal of Clinical and Experimental Dentistry*. 2015: e414-e418.