Prevalence and Awareness of Ergonomics and Physical Activities in Controlling Work-Related Musculoskeletal Disorders Among Dental Students: A Cross-Sectional Study

Heba Sabbagh (✉ hsabbagh@kau.edu.sa)  
King Abdulaziz University

Asma Shagagi  
King Abdulaziz University

Hanin Basheer  
King Abdulaziz University

Rawa Mahmoud  
International Medical Center

Research Article

Keywords: ergonomics, work-related musculoskeletal disorders, dental students, musculoskeletal pain, lower back pain, neck pain

Posted Date: October 21st, 2021

DOI: https://doi.org/10.21203/rs.3.rs-964663/v1

License: © This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License
Abstract

Background
To assess the prevalence and awareness of ergonomics and physical activities in controlling work-related musculoskeletal disorders (MSDs) among dental students, interns, and postgraduates at King Abdulaziz University in Jeddah, Saudi Arabia.

Methods
This cross-sectional study was conducted at King Abdulaziz University through a validated self-administered questionnaire. It was distributed among dental students from the fourth academic year to postgraduate level.

Results
A total of 402 students responded to the questionnaire; 337 (83.8%) reported suffering from musculoskeletal pain with 67.7% of participants did not take any measures to alleviate their symptoms and the majority reported limited physical activity. Females reported significantly higher MSD symptoms than males. Based on the location of the MSD pain, lower back pain (56.5%), neck pain (56.2%) and shoulder (50%) were the most frequently reported MSDs. There was a statistically significant difference in pain at various academic levels with undergraduate students reporting more pain than interns and postgraduate students (P= 0.009). The dental students’ awareness of ergonomics and MSDs was found to be insufficient.

Conclusion
The prevalence of work-related MSDs is high among dental students at King Abdulaziz University, and awareness of ergonomics and MSDs among dental students is limited.

Background
Dentistry is a profession that demands a high level of physical work and excessive repetitive movements, both of which are risk factors for developing Musculoskeletal Disorders (MSDs).[1] MSDs are injuries to the muscles, bones, nerves, joints, ligaments, and blood vessels of the body. In the long term, the accumulation of such injuries can result in a more severe injury.[2] Over the past several years, MSDs have been documented to increase in routine work. MSD is a widespread phenomenon and the most common cause of chronic pain and disability.[3] Previous studies have reported that the incidence of MSDs is high among dentists. According to a systematic study, the prevalence of general musculoskeletal pain in dentists can range 64–93%,[4] appearing slowly in new dentists and progressing throughout the life.[1, 5] In Saudi Arabia, the prevalence of MSD symptoms among dentists is also high.[6, 7] A study suggested that it starts during the early educational years.[5, 6] The prevalence of MSDs was reported among 90.2% of 184 dentists in Riyadh, Saudi Arabia.[8] Such high numbers suggest the importance of ergonomic training right from a dental student’s early years of education to prevent work-related MSDs in the future.[9] Furthermore, a study reported that less than one-third of dentists had learned about MSDs, as most of them were not introduced to ergonomics except in tertiary education.[10]

According to research, physical activity plays a significant role in the reduction of musculoskeletal pain in dentists.[11, 12] If ergonomics and physical activity were introduced in the field of dentistry at the academic level, it could help improve cognitive and physical stress, reduce workplace hazards, and, therefore, ensure the comfort and quality of service of dentists.[13] Although previous studies have reported the prevalence of MSDs among professional dentists, no study has focused on MSDs faced by dentists during their educational years (undergraduate and graduate levels). Based on the knowledge that awareness of ergonomics and physical exercise are best developed during the education years of dentists,[2, 14] this study aimed to assess the prevalence of work-related MSDs among undergraduate, interns and postgraduate dental students and related factors. In addition, we assessed the students’ awareness of ergonomics and physical activities in controlling work-related MSDs at King Abdulaziz University, Jeddah, Saudi Arabia.

Methods
This cross-sectional study was conducted at King Abdulaziz University in Jeddah, Saudi Arabia, from August 2020 to April 2021. The study was reviewed and approved by the Research Ethics Committee 196-12-20 of the Faculty of Dentistry at King Abdulaziz University. All students in the fourth, fifth, sixth, years undergraduates, internship and postgraduate levels studying at King Abdulaziz University were included in this study (610 participants). The inclusion criteria comprised dental students who were exposed to clinical dental work. Students without dental work-related musculoskeletal disorders were excluded from the study. Interns were considered students as they were supervised at all times during their clinical training and their training is part of their education for graduation. In addition, their work-related MSDs were compared with undergraduate students.

Data was collected through a self-administered validated questionnaire that included three parts. The first part assessed the students’ demographic data, academic year, level of education, and level of physical activity according to a validated scale (IPAQ scoring protocol).[15] The second part of the questionnaire assessed their working conditions, MSDs, and symptoms, based on the general questionnaire of the Standardized Nordic questionnaire.[16] The third part assessed students’ awareness of MSDs and was constructed after reviewing existing literature. The questions were assessed using a five-point Likert scale ranging from 1 "strongly agree" and 5 "strongly disagree."
The validation of the questionnaire used in this study went through two phases. The first phase was a content assessment by six qualified dentists and physiotherapists (CVI = 0.94). The second was face validity through interviews with a group of 10 dental students. The Cronbach's alpha coefficient was 0.762.

The questionnaire was distributed online to students using Google Forms. The data was processed and analyzed using the SPSS software. The categorical variables were presented as frequencies and percentages and compared using the chi-square test. The continuous variables were presented as mean and standard deviations and compared using the t-test. Logistic regression analysis was conducted to assess the effects of confounders and adjust the P-value accordingly. Musculoskeletal pain and its different types were entered as “dependent factors;” students’ education level was grouped into “undergraduate,” “interns,” and “postgraduate;” and gender and physical activity were entered as “independent factors.” The significance level was set at p < 0.05.

**Results**

The questionnaire was distributed to 610 students. Of these, 402 students participated, resulting in a 65.9% response rate. Table 1 shows the demographic distribution of the sample, including 200 (49.8%) males, 202 (50.2%) females, 145 (36%) undergraduates, 156 (38.8%) interns, and 101 (25.1%) postgraduates. The 145 undergraduates included 56 (38.6%) from the fourth year, 44 (30.3%) from the fifth year, and 45 (31.1%) from the sixth academic year, respectively.
Table 1

Distribution of students according to gender, academic year, level of physical activity, and type of musculoskeletal pain.

| Variable                             | N (%)               |
|--------------------------------------|---------------------|
| Gender                               |                     |
| Female                               | 202 (50.2%)         |
| Male                                 | 200 (49.8%)         |
| Academic year                        |                     |
| 4th y                                | 56 (13.9%)          |
| 5th y                                | 44 (10.9%)          |
| 6th y                                | 45 (11.2%)          |
| Intern                               | 156 (38.8%)         |
| Postgraduate                         | 101 (25.1%)         |
| Physical activity level              |                     |
| High level                           | 68 (16.9%)          |
| Moderate level                       | 279 (69.4%)         |
| Low level                            | 55 (13.7%)          |
| Do you have musculoskeletal pain     |                     |
| Yes                                  | 337 (83.8%)         |
| No                                   | 65 (16.2%)          |
| Site of musculoskeletal pain         |                     |
| Neck                                 | 226 (56.2%)         |
| Shoulders                            | 201 (50.0%)         |
| Elbows                               | 53 (13.2%)          |
| Wrists\hands                         | 194 (48.3%)         |
| Upper Back                           | 148 (36.8%)         |
| Lower Back                           | 227 (56.5%)         |
| One\Both legs                       | 38 (9.5%)           |
| Hips\Buttocks                       | 35 (8.7%)           |
| One\Both Knees                      | 58 (14.4%)          |
| Headache                             | 175 (43.5%)         |
| At which work you feel the most pain?|                     |
| Prosthodontics                       | 8 (2.0%)            |
| Endodontics                          | 27 (6.7%)           |
| Periodontics                         | 7 (1.7%)            |
| Restorative Dentistry                | 26 (6.5%)           |
| Surgery                              | 9 (2.2%)            |
| Pediatric Dentistry                  | 12 (3.0%)           |
| Orthodontics                         | 1 (0.2%)            |
| Not specific                         | 312 (77.6%)         |
| Did you use self-management strategies, visited a physician or physical therapy for your musculoskeletal complains | |
| Yes                                  | 68 (16.9%)          |
| No                                   | 272 (67.7%)         |
| Not applicable                       | 68 (16.9%)          |

Musculoskeletal pain was reported in 337 students (83.8%). The remaining 65 students reported no musculoskeletal pain in any part of their body (16.2%). According to the location of the MSD-related pain, lower back pain (56.5%) and neck pain (56.2%) were the most frequently reported, followed by shoulder pain (50.0%) and wrist pain (48.3%). The majority of pain was reported during the practice of endodontics (6.7%), followed by restorative dentistry (6.5%), and pediatric dentistry (3.0%), while the least pain was reported in orthodontics (0.2%). Regarding pain management, 68 (16.9%) participants reported having self-managed their symptoms, either by visiting a physician or undergoing physical therapy for their complaints; 272 (67.7%) participants did not take any measures to alleviate their symptoms, and 4 (1%) participants did not know how to manage their symptoms.

Table 2 shows the distribution of musculoskeletal pain among undergraduate students (145 students). Musculoskeletal pain was reported in 53 (94.6%) fourth year, 42 (65.5%) fifth year, and 38 (84.4%) sixth year students. All undergraduates who reported low levels of physical activity reported musculoskeletal pain was reported in 53 (94.6%) fourth year, 42 (65.5%) fifth year, and 38 (84.4%) sixth year students.
pain. The P-value adjusted for the relationship between musculoskeletal pain (dependent variable) and academic year, gender, and physical activity (independent variables) was not statistically significant (P>0.05).

Table 2
Distribution of the sample according to work-related pain among undergraduate academic years and its relationship to gender and reported level of physical activity (N=145)

| Do you have pain | Total |
|------------------|-------|
| Yes              | No    | Adjusted P value, OR (CI) |
| Academic year    |       |                            |
| 4th y            | 53 (94.6) | 3 (5.4) | 56 (100) |
| 5th y            | 42 (95.5) | 2 (4.5) | 0.108, 0.305(0.072-1.30) | 44 (100) |
| 6th y            | 38 (84.4) | 7 (15.6) | 0.070, 0.20(0.035-1.143) | 45 (100) |
| Gender           |       |                            |
| Female           | 69 (92.0) | 6(8) | 0.964, 1.036(0.22-4.84) | 202(100) |
| Male             | 64 (91.4) | 6(8.6) | 200(100) |
| Level of physical activity |       |                            |
| High             | 26 (86.7) | 4(13.3) | 68(100) |
| Moderate         | 87 (91.6) | 8(8.4) | 0.43, 0.6(0.17-2.14) | 95(100) |
| Low              | 20 (100) | 0 | 20(100) |
| Total            | 133(91.7) | 12(8.3) |

Table 3 shows the distribution location (site) of musculoskeletal pain based on students’ level of education (undergraduate, interns, and postgraduate), gender, and level of physical activity. Undergraduate students reported more pain (91.7%) than interns (75.6%) and postgraduates (85.1%). However, the P-value was statistically significant only for interns (adjusted P = 0.045, OR: 0.43, 95% CI: 0.19 0.98). In addition, female students reported more pain (89.6%) than males (78%), and the difference was statistically significant (adjusted P = 0.014, OR: 0.48, 95% CI: 0.26 0.86). Furthermore, students with low (98%) and moderate (82.2%) physical activity reported more pain compared to those with high physical activity (76.5%), with adjusted P = 0.015, OR: 13.2 and 95% CI: 1.64 to 105.46; and adjusted P = 0.027, OR: 9.07 and 95% CI: 1.20 to 68, respectively.
| MSDs          | education level | Gender | Level of physical activity |
|--------------|----------------|--------|-----------------------------|
|              | Undergrad n=145 | Intern n=156 | Postgrad n=101 | Female n=202 | Male n=200 | High r n=68 | Moderate n=279 | Low n=55 |
| Do you have MSD pain? Yes | 133(91.7) | 118 (75.6) | 86 (85.1) | 181 (89.6) | 156 (78) | 52 (76.5) | 231 (82.8) | 54 (98.2) |
| Adjusted P value, OR (CI) | 0.004* | 0.045(0.19-0.98) | 0.33(1.22-2.72) | 0.014*0.48(0.26-0.86) | 0.05* | 0.015*13.2(1.64-105.46) | 0.027*9.07(1.20-68.22) |
| Neck pain | Yes | 87 (60) | 83 (53.2) | 56 (55) | 127 (62.9) | 99 (49.5) | 24 (35) | 164 (58.8) | 38 (16.8) |
| Adjusted P value, OR (CI) | 0.367 | 0.218(0.42-1.23) | 0.869(0.95-1.6) | 0.077(0.69-1.05) | 0.002* | 0.001*3.76(1.72-8.2) | 0.167(0.83-2.9) |
| Shoulder pain | Yes | 75 (51.7) | 76 (44.9) | 50 (49.5) | 115 (56.9) | 86 (43) | 21 (30.9) | 143 (51.3) | 37 (67.3) |
| Adjusted P value, OR (CI) | 0.653 | 0.23(0.42-1.23) | 0.84(0.95-1.6) | 0.08(0.45-1.05) | 0.002* | 0.001*3.76(1.72-8.2) | 0.167(0.83-2.9) |
| Elbow's pain | Yes | 13 (8.9) | 26 (16.7) | 14 (13.8) | 25 (12.3) | 28 (14) | 1 (1.9) | 45 (16.2) | 7 (12.7) |
| Adjusted P value, OR (CI) | 0.296 | 0.34(1.47-3.52) | 0.36(1.38-1.63) | 0.35(1.47-2.5) | 0.048* | 0.027*11.4(1.33-97.6) | 0.66(3.44-1.98) |
| Wrist\Hand's pain | Yes | 79 (54.5) | 76 (47.7) | 39 (38.6) | 110 (54.5) | 84 (42) | 29 (42.6) | 142 (50.9) | 23 (41.8) |
| Adjusted P value, OR (CI) | 0.040* | 0.013(0.51-0.87) | 0.116(0.65-1.1) | 0.018(0.61-0.92) | 0.572 | 0.74(0.91-1.48) | 0.33(0.73-1.33) |
| Upper back pain | Yes | 69 (47.5) | 37 (23.7) | 42 (41.6) | 86 (42.5) | 62 (31) | 15 (22) | 108 (38.7) | 25 (45.4) |
| Adjusted P value, OR (CI) | <0.0001* | 0.21(0.42-1.21) | 0.007*2.15(1.2-3.74) | 0.14(0.73-1.12) | 0.045* | 0.027*2.5(1.12-5.72) | 0.66(1.14-2.08) |
| Lower back pain | Yes | 94 (64.8) | 67 (42.9) | 66 (65.3) | 126 (62.4) | 101 (50.5) | 31 (45.5) | 158 (56.6) | 38 (69.1) |
| Adjusted P value, OR (CI) | 0.001* | 0.89(0.55-1.62) | 0.002*2.29(1.35-3.88) | 0.10(0.46-1.07) | 0.131 | 0.057(0.98-4.6) | 0.31(0.76-2.71) |
| One\Both legs pain | Yes | 12 (8.3) | 14 (8.9) | 12 (11.9) | 29 (14.4) | 9 (4.5) | 3 (4.4) | 24 (8.6) | 11 (20) |
| Adjusted P value, OR (CI) | 0.857 | 0.61(1.53-3.05) | 0.92(1.05-2.47) | 0.004(0.31-0.68) | 0.042 | 0.073(0.36-0.14) | 0.2(2.61(1.15-5.89) |
| Hip\Buttock's pain | Yes | 16 (11) | 10 (6.4) | 9 (8.9) | 21 (10.4) | 14 (7) | 6 (8.8) | 22 (7.8) | 7 (12.7) |
| Adjusted P value, OR (CI) | 0.369 | 0.45(0.31-1.78) | 0.6(0.29-2.03) | 0.20(0.63-1.34) | 0.484 | 0.69(0.38-4.22) | 0.27(0.65-4.11) |
| One\Both knees pain | Yes | 18 (12.4) | 24 (15.3) | 16 (15.8) | 41 (20.3) | 17 (8.5) | 7 (10.3) | 39 (13.9) | 12 (21.8) |
| Adjusted P value, OR (CI) | 0.576 | 0.61(0.57-2.55) | 0.68(0.42-1.77) | 0.002(0.37-0.197) | 0.376 | 0.31(0.6-4.95) | 0.17(0.81-3.67) |
| Headache | Yes | 63 (43.4) | 52 (33.3) | 60 (59.4) | 114 (56.4) | 61 (30.5) | 14 (20.5) | 128 (45.8) | 33 (60) |
| Adjusted P value, OR (CI) | 0.005* | 0.23(1.33) | 0.001(4.56-1.46) | <0.001(0.22-0.54) | 0.002* | 0.001(4.45(1.89-10.5) | 0.13(1.67(0.87-3.2) |

* reference category, *P < 0.05

Concerning the location of pain, hand and wrist pain were statistically more frequent among females compared to males (adjusted P = 0.018, OR: 0.61 and 95% CI: 0.4 to 0.92) and lower among interns (adjusted P = 0.013, OR: 0.51 and 95% CI: 0.3 to 0.87); upper and lower back pain were statistically more
frequent among postgraduates (higher educational level) compared to undergraduate students (adjusted P = 0.007, OR: 2.15 and 95% CI: 1.2 to 3.74; and adjusted P = 0.002, OR: 2.29 and 95% CI: 1.35 to 3.88, respectively) and more frequent upper back pain for those with lower physical activity (adjusted P = 0.027, OR: 2.5 and 95% CI: 1.12 to 5.72), leg pain was statistically more frequent among females compared to males (adjusted P = 0.004, OR: 0.31 and 95% CI: 0.14 to 0.68), knee joint pain was statistically more frequent among females (adjusted P = 0.002, OR: 0.37 and 95% CI: 0.197 to 0.69), and headache was statistically more frequent among higher educational level students and interns compared to undergraduates (P=0.005*), and higher among females compared to males (adjusted P<0.001, OR: 0.34 and 95% CI: 0.22 to 0.54).

Significant correlations were found in the level of physical activity among students; those with moderate level of physical activity had more neck pain (adjusted P = 0.001, OR: 3.76, 95% CI: 1.72 to 8.2), shoulder pain (adjusted P = 0.001*, OR: 3.76, 95% CI: 1.72 to 8.21), elbow pain (adjusted P=0.027, OR: 11.4, 95% CI: 1.33 to 97.6), and headache (adjusted P = 0.001, OR: 4.45, 95% CI: 1.89 to 10.5).

Table 4 shows the mean of students’ awareness of work-related MSDs and ergonomics distributed according to their educational level. Undergraduate students reported having more knowledge (2.39±1.09), sufficient lectures about MSDs (2.41±1.18), knew that physical activity is essential to relieve symptoms (2.21±1.05), and that their supervisors guided them to maintain proper posture (2.43±1.15) compared to interns (3.41±1.48; 3.47±1.52; 1.80±1.06; 2.97±1.00; and 2.97±1, respectively), and the differences were statistically significant (P<0.0001). Therefore, undergraduates reported more knowledge about MSDs than postgraduates (P<0.0001).

### Table 4

| MSDs Knowledge                                      | Undergraduate | Intern | Postgraduate |
|-----------------------------------------------------|---------------|--------|--------------|
|                                                     | mean ± SD     | n=145  | mean ± SD    | n=156  | mean ± SD    | n=101  |
| I have enough information about MSDs or ergonomics  | 2.39±1.09     |        | 3.41±1.48    |        | 2.4±1.21     |        |
| P value                                             | <0.0001*      |        | <0.0001*     |        |              |        |
| Information in the lecture was enough about MSDs or | 2.41±1.18     |        | 3.47±1.52    |        | 3.3±1.14     |        |
| ergonomics                                          |               |        |              |        |              |        |
| P value                                             | <0.0001*      |        | <0.0001*     |        |              |        |
| I need more information about MSDs or ergonomics    | 2.30±1.17     |        | 1.80±1.06    |        | 2.07±1.11    |        |
| P value                                             | <0.0001*      |        |              |        | 0.26         |        |
| I know that I have bad ergonomics                   | 2.21±1.05     |        | 1.72±0.94    |        | 2.13±1.05    |        |
| P value                                             | <0.0001*      |        |              |        | 0.82         |        |
| Physical activities are essential to relieve the    | 1.77±0.80     |        | 2.37±1.15    |        | 1.81±0.95    |        |
| symptoms                                            |               |        |              |        |              |        |
| P value                                             | <0.0001*      |        |              |        | 0.93         |        |
| My supervisors always guide me to the right posture | 2.43±1.15     |        | 2.97±1.00    |        | 2.72±0.98    |        |
| in the clinics                                       |               |        |              |        | 2.71±1.08    |        |
| P value                                             | <0.0001*      |        |              |        | 0.09         |        |

Distribution was based on a mean of 1 to 5 (1 = strongly agree, 2 = agree, 3 = neutral, 4 = disagree, and 5 = strongly disagree).

| r reference category                             |
|--------------------------------------------------|
|        *P< 0.05 according to Tukey Post-Hoc test   |

**Discussion**

In the present study, the prevalence of MSDs was found to be high among dental students and was related to their gender, educational level, and level of physical activity. Moreover, students reported limited awareness of ergonomics and work-related MSDs.

Studies have reported that MSDs increase during routine dental procedures if not prevented or treated early. Due to maintaining a static posture for prolonged periods and the use of precise hand and wrist movements, dentists have been found to have a higher prevalence of MSDs than office employees and other professionals.[17, 18] According to the existing literature on MSDs among dentists, these symptoms have contributed significantly to morbidity, as well as lowering the productivity and quality of work of dentists, and likely to lead to premature retirement.[19]

A thorough understanding of the underlying mechanisms is necessary to develop and implement a comprehensive approach to minimize the risks of work-related MSDs. Awareness is the first critical step in neutralizing ergonomic habits and work environment layouts that might otherwise unnecessarily jeopardize professional clinical careers.

Although the prevalence of MSDs in dentistry has been studied in the past, there are limited studies on dentistry students and MSD prevention. Therefore, this study is novel in assessing and comparing different educational levels since the initial years to further understand the origin of MSD symptoms in students.
Interns were considered part of the educational system as they still take lectures and are receiving advanced training at the university as well. The prevalence of work-related musculoskeletal pain among students was 83.8%, which was supported by previous global studies that ranged from 64–93%.[4] In addition, Meisha et al. (2019) [17] reported 70% and Al-Mohrej et al. (2017)[8] reported a 90.2% prevalence of work-related MSDs among dentistry practitioners in Jeddah city. Although the differences are minimal, the variation in the prevalence of MSDs could be because students are exposed to greater stress, academic demands, and anxiety with longer sitting times during lectures and studying for long hours after attending their clinics.[20]

The most common location of MSDs in this study was the lower back (56.5%), followed by the neck (56.2%), while the least common location of MSDs was the hips (8.7%) and legs (9.5%). These findings were similar to previous literature on dentistry practitioners.2,15[14, 17, 21] The reasons suggested for these types of pain were sitting in one posture for a long time, unhealthy working habits, lack of support to the hands, limited visual field, and small cavities, which restrict the movement of the shoulder and neck resulting in pain.1,2,37,15

When comparing different dental specialties, our study showed that the most pain occurred during practicing endodontics (6.7%), followed by restorative dentistry (6.5%) and pediatric dentistry (3.0%); these findings are similar to previous studies conducted on professional dentists.[2, 17] attributed to risk factors including reparative motion, use of force, stress, occupational demand, vibrations, and prolonged static posture during these procedures.[22, 23]

Regarding the prevalence of musculoskeletal pain among undergraduate students, 91.7% reported musculoskeletal pain, which was high compared to undergraduate students in medical and other health sciences colleges, which ranged from 60–73%.[24, 25] In addition, this study showed a decline in musculoskeletal pain as the undergraduate students’ academic years progressed, which was also supported by studies conducted on medical and other health specialty students.[25] However, after adjusting the P-value, this decrease was not statistically significant. However, this tendency might indicate that students who sit for long hours of lectures and have less mobility, for example, those in the fourth year are more prone to musculoskeletal pain compared to higher education level students.[20] Another explanation could be that fourth year students are newly exposed to the stressors and risk factors associated with the clinical practice of dentistry.[26] We also found the same trend when comparing postgraduates with undergraduates. Postgraduates reported less frequent musculoskeletal pain.

Females reported more frequent musculoskeletal pain than males, which is consistent with the findings of previous studies.[14, 17] A study by Presoto et al. suggested that this may be due to biological differences between genders, such as muscle capacity or hormones, or psychological differences.[13] Another study found that females have significantly higher sitting times during the week and weekends,[20] which contributes to a higher incidence of MSDs. Moreover, female students were reported to be more prone to stress, anxiety, and depression than males,[27] which are risk factors for neck and back pain.[28]

When comparing the presence of pain according to educational levels (undergraduate, interns, and postgraduates), the prevalence of MSDs was significantly lower among interns than among undergraduates. This could be because, although interns are being trained in the university, they are exposed to less stress and have fewer academic demands. When analyzing the types of MSDs at different educational levels, undergraduates had the highest neck pain (60%), shoulder pain (51.7%), wrist and hand pain (54.5%), and upper back pain (47.5%), while the postgraduates had the lowest back pain (65.3%), leg pain (11.9%), knee pain (15.8%), and headache (59.4%).

The prevalence of neck pain in undergraduate students is high.[29] After reviewing existing literature, we found several risk factors that could have contributed to this high rate, such as prolonged sitting time—in lectures, during study hours, or at clinics—which increases the muscle load on the neck and shoulders. A study found a significant relationship between neck pain and grip strength among dental students; those who used higher grip forces had more pain compared to students who used lower grip forces.[30]

Regarding psychological factors, undergraduate students have shown high levels of depression, anxiety, and stress.[27] A systematic review found a strong association between neck pain and psychological factors such as high job strain and demands, low supervisor and social support, and limited rest or break opportunities.[28]

Since undergraduates are becoming accustomed to using instruments and maintaining the required postures in clinics, it is understandable that they experience upper body pain. However, with bad posture and repetitive motions over the years without appropriate physical activity and ergonomic tools, they eventually develop chronic lower back pain and headache that will only worsen if not treated early, as we found among the postgraduate students.

We found an inverse relationship between the level of physical activity and MSDs. Students with high levels of physical activity developed less pain than those with fewer physical activities. Interestingly, 100% of undergraduate students with low levels of physical activity experienced MSD-related pain. This finding is supported by previous studies that reported the importance of physical activity in controlling musculoskeletal pain.[19, 31, 32]

Additionally, more students with moderate levels of physical activity complained of pain in the neck (58.8%), shoulders (51.3%), elbows (16.2%), and headache (45.8%), compared to students with high levels of activity. Previous studies have found that participants tend to be confused about the components of moderate physical activity recommendations and underestimate the intensity needed to obtain health benefits.[33, 34] Therefore, we can conclude that many students who thought they had moderate levels of physical activity had lower levels of physical activity, which may explain the high pain rates. In addition, a large number of participants did not undertake any management strategies for their MSDs (67.7%), such as visiting a physician or undergo physical therapy.

Ergonomics can play a major role in the effectiveness of dental health care delivery systems and should be implemented and reinforced as part of students’ education, training, and assessment.[9] Students reported limited awareness of work-related MSDs and ergonomics. However, undergraduates were more satisfied with the amount of knowledge they received on MSDs compared to interns and postgraduates. Previous studies found that although students have a fair knowledge of ergonomics, very few apply them in their practice.[21, 35] Thus, clinical supervisors need to be strict with students and enforce ergonomics in clinical and laboratory settings.[6]
Moreover, ergonomics will play an important part in mitigating MSDs in education centers, which can be achieved by including more breaks for students, encouraging stretching between sessions, and influencing the importance of ergonomics, proper posture, and physical activities to prevent the occurrence of MSDs.\[18, 32\]

Although the present study reveals important findings, it has some limitations. The limitations include a low response rate (66%) even though the sample was distributed equally according to gender (almost 50% males and females) and educational level (almost 30% from each of the three educational groups: undergraduate, postgraduate, and interns). Another limitation was related to recall bias, which was reported in a previous study that assists recall bias effect on back pain recall. They reported good agreement at the group level.\[36\]

Conclusions
The prevalence of work-related musculoskeletal pain is high among dental students at King Abdulaziz University. Sex, level of education, and physical activity were the major risk factors for MSDs. However, students’ awareness of ergonomics and physical activity in controlling MSDs is limited. Therefore, we need to enhance the awareness of using ergonomic tools for proper posture and encourage physical activities to reduce and control MSDs among dental students and during the university hours.

Abbreviations
MSDs
- musculoskeletal disorders
IPAQ
- International Physical Activity Questionnaire

Declarations
Ethics approval and consent to participate
Written informed consent was obtained from all participants (All participants were above 16 years of age). An ethical approval was obtained from the ethics committee of KAUFD (196-12-20)

Consent for publication
Written informed consent for publication was obtained from the students and approved by the KAUFD ethical committee. A copy of the consent form is available for review by the Editor of this journal if requested from the corresponding author.

Availability of data and materials
Data generated or analyzed during this study are included in this published article.

Competing interests
There are no competing interests.

Funding
Not applicable.

Authors’ contributions
HS contributed in designing the work, collecting and analyzing the data, interpreting the results, writing the manuscript and revising the final draft. AS and HB contributed in designing the work, collecting the data, and writing the manuscript. RA contributed in designing the work, data acquisition and writing the manuscript. All authors read and approved the final manuscript.

Acknowledgements
We would like to thank Editage (www.editage.com) for English language editing.

References
1. Rising DW, Bennett B, Hursh K, Plesh O: Reports of body pain in a dental student population. Journal of the American Dental Association 2005, 136:81–86.
2. Pek J N, Petrovij V, Markovic D, Milj J B, Dimitrijev I, Perunovic N. S: Assessment of risk factors and preventive measures and their relations to work-related musculoskeletal pain among dentists. Work 2017, 57:573–593.
3. Ayers K, Thomson W, Newton J, Morgaine K, Rich A: Self-reported occupational health of general dental practitioners. Occupational medicine 2009, 59:142–148.
4. Hayes M, Cockrell D, Smith DR: A systematic review of musculoskeletal disorders among dental professionals. *International Journal of Dental Hygiene* 2009, 7(3):159–165.

5. Abduljabbar A: Musculoskeletal Disorders among Dentists in Saudi Arabia. In: 2008, 2008.

6. Alyahya F, Algarzaie K, Alsuebe Y, Khounganian R: Awareness of ergonomics & work-related musculoskeletal disorders among dental professionals and students in Riyadh, Saudi Arabia. *Journal of Physical Therapy Science* 2018, 30:770–776.

7. Ijaz A, Khan I, Ahmed A, Sadiq S: Frequency of neck pain among dentists. *Pakistan Orthodontic Journal* 2016, 8:89–93.

8. Al-Mohrej O, Alshaalaan NS, Al-Bani WM, Masuadi E, Almodaimegh H: Prevalence of musculoskeletal pain of the neck, upper extremities and lower back among dental practitioners working in Riyadh, Saudi Arabia: a cross-sectional study. *BMJ Open* 2016, 6.

9. Khalil T: Dentistry: a growing domain for ergonomics. *Ergonomics* 1974, 17:1:75–86.

10. Sakzewski L, Naserud-Din S: Work-related musculoskeletal disorders in dentists and orthodontists: a review of the literature. *Work* 2014, 48:1:37–45.

11. Fayezy E: The Correlation between Neck Pain and Hand Grip Strength of Dentists. *Occupational Medicine and Health Affairs* 2014, 2014:1–4.

12. Khan R: Prevalence of Work Related Musculoskeletal Disorders (MSD) among Dentists. *International Journal of Contemporary Medical Research* 2017, 4.

13. G.N K, Rajeshwari K: Dentists Knowledge, Attitude and Behavior towards the Dental Ergonomics. *IOSR Journal of Dental and Medical Sciences* 2014, 13:86–89.

14. Alrumi A, Alsheraimi A, Alassaf S, Abdulmajeed, Alharbi, Alenezi A, Almajed A, Alshetan N, Khaled, Alomairiy G.N K, Rajeshwari K: Prevalence of Work Related Musculoskeletal Disorders among Dental Students, Interns, and Residents In Riyadh, Saudi Arabia. In: 2020, 2020.

15. *International Physical Activity Questionnaire (IPAQ)*. In. www.ipaq.ki.se.

16. Kuorinka I, Jonsson B, Kilborn A, Vinterberg H, Biering-Sorensen F, Andersson G, Jørgensen K: Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied ergonomics* 1987, 18(3):233–237.

17. Meisha D, Alsharqawi NS, Samarah AA, Al-Ghamdi MY: Prevalence of work-related musculoskeletal disorders and ergonomic practice among dentists in Jeddah, Saudi Arabia. *Clinical, Cosmetic and Investigational Dentistry* 2019, 11:171–179.

18. Alghadir A, Zafar H, Iqbal Z: Work-related musculoskeletal disorders among dental professionals in Saudi Arabia. *Journal of Physical Therapy Science* 2015, 27:1107–1112.

19. Sharma P, Golchha V: Awareness among Indian dentist regarding the role of physical activity in prevention of work related musculoskeletal disorders. *Indian Journal of dental research: official publication of Indian Journal of Dental Research* 2011, 22:3:381–384.

20. D’Abundo M, Sidman C, Fiala KA: Sitting Behavior and Physical Activity of College Students: Implications for Health Education and Promotion. *Int J Adult Vocat Educat Technol* 2015, 6:61–78.

21. Gaogwzeh R, Chevidikunnan MF, Saif AAA, El-Gendy SR, Karrouf G, Senany SA: Prevalence of and risk factors for low back pain among dentists. *Journal of Physical Therapy Science* 2015, 27:2803–2806.

22. Wang SY, Liu LC, Lu M, Koo M: Comparisons of Musculoskeletal Disorders among Ten Different Medical Professions in Taiwan: A Nationwide, Population-Based Study. *PLoS ONE* 2015, 10.

23. Costa BDd, Vieira E: Risk factors for work-related musculoskeletal disorders: A systematic review of recent longitudinal studies. *American Journal of Industrial Medicine* 2010, 53:3:285–323.

24. Senarath M, Thalwaththe S, Tennakoon S: Prevalence of Selected Musculoskeletal Disorders among the Students of Faculty of Allied Health Sciences. *University of Peradeniya*. In: 2021, 2021.

25. Hendi OM, Abdulaziz A, Althaqami AM, Hindi AM, Khan SA, Atalla A: Prevalence of Musculoskeletal Disorders and Its Correlation to Physical Activity Among Health Specialty Students. *International Journal of Preventive Medicine* 2019, 10.

26. Gupta A, Ankola A, Hibel M: Optimizing human factors in dentistry. *Dental Research Journal* 2013, 10:254–259.

27. Fawzy M, Hamed S: Prevalence of psychological stress, depression and anxiety among medical students in Egypt. *Psychiatry Research* 2017, 255:186–194.

28. Ariëns G, Mechelen Wv, Bongers P, Bouter LM, Wal Gvd: Psychosocial risk factors for neck pain: a systematic review. *American Journal of Industrial Medicine* 2001, 39:2:180–193.

29. Kanchanomai S, Janwantanakul P, Pensri P, Jiamjarasrangsi W: Risk factors for the onset and persistence of neck pain in undergraduate students: 1-year prospective cohort study. *BMC Public Health* 2011, 11(1):566.

30. Díaz-Caballero A, Gómez-Palencia I, Díaz-Cárdenas S: Ergonomic factors that cause the presence of pain muscle in students of dentistry. *Medicina Oral, Patología Oral y Cirugía Bucal* 2010, 15:6:906-911.

31. Rundcrantz BL, Johnsson B, Moritz U: Pain and discomfort in the musculoskeletal system among dentists. A prospective study. *Swedish Dental Journal* 1991, 15:5:219–228.

32. Sahu D, Tandon S, Dhingra S, Chinmaya B, Prasad S, Bari E, Ghosh A: Prevalence of musculoskeletal disorders among dentists: A pilot cross-sectional survey. *Journal of Indian Association of Public Health Dentistry* 2015, 13:307–312.

33. Behrens TM, Dinger M, Heesch K, Sisson S: College students’ understanding of moderate physical activity: A qualitative study. In: 2005, 2005.

34. Canning K, Brown RE, Jamnik V, Salmon A, Ardern C, Kuk J: Individuals Underestimate Moderate and Vigorous Intensity Physical Activity. *PLoS ONE* 2014, 9.

35. El-sallamy R, Atlam S, Kabbash I, El-fatah SA, El-flaky A: Knowledge, attitude, and practice towards ergonomics among undergraduates of Faculty of Dentistry, Tanta University, Egypt. *Environmental Science and Pollution Research* 2017, 25:30793-30801.
36. Rasmussen CDN, Holtermann A, Jørgensen MB: Recall Bias in Low Back Pain Among Workers: Effects of Recall Period and Individual and Work-Related Factors. *Spine* 2018, 43(12):E727-e733.