Review

The prevalence of occupational health-related problems in dentistry: A review of the literature

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Abstract: The study was conducted to report on the scope and prevalence of occupational health-related problems experienced by dentists, dental therapists, and oral hygienists in their practice of dentistry. Background: Professional practice and dental training have many risk factors, and the dental team should be able to recognize these factors to protect themselves. The prevalence of conditions related to the musculoskeletal system, stress, percutaneous injuries, ears, and eyes are of concern. The dental team should also not forget hepatitis B, hepatitis C, and HIV as risks in practice. Dental practitioners should protect themselves by self-recognizing risk factors and by maintaining proper working conditions. Methods: The study targeted all empirical research, case studies, and systematic literature reviews written in English. All articles selected were subjected to a data analysis process. Data were captured on an Excel spreadsheet and reported in a comprehensive table. Results: The literature addressing occupational health among dental practitioners included mainly cross-sectional studies and review papers (2001-2016). Forty-nine studies were included in the review. Musculoskeletal disorders remain the most researched occupational health-related problems in dentistry. Eye protection compliance was low among practitioners. Percutaneous injuries especially among young dentists and students were still a concern. Conclusion: Occupational health-related problems are still prevalent in current dentistry practice, despite changes in equipment and surgery design. The reported prevalence of occupational-related health problems and other findings of investigative studies highlight the need for continuous professional education and a need to improve clinical practice aspects of dentistry curricula.

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Introduction

Dental practitioners in dentistry training and practice environments are challenged with a number of occupational health barriers. The dental worker is prone to physical and psychological stressors which are aggravated by the work environment¹. Irrespective of where one works, the goal is to be in a safe environment without having fear of incurring work-based injuries. It is important to have a “philosophy of prevention” which should be followed to reach health and safety goals². Occupational health is a multidisciplinary and comprehensive approach which aims to protect and promote the health of a worker. The enhancement of physical, mental, and social well-being will ensure that workers live productive lives³.

Dental workers are prone to occupational health-related problems occupational health problems, with dental hazards being of a physical, biological, chemical, and psychosocial nature⁴. Musculoskeletal disorders (MSDs), eye injuries, vibration-induced neuropathy, and psychological conditions are some of the poor health outcomes due to occupational health issues⁵. Problems such as contact dermatitis, hearing loss, and toxicity from materials used during dental practice have also been noted. Other risks include incidents due to exposure to infectious diseases, radiation, and noise, and allergy to dental materials⁶. The prevention of such injuries should be included in educa-
tion and training, to reduce occupation-related health problems among dental workers. This paper reports on the scope and prevalence of occupation-related health problems experienced by dentists, dental therapists, and oral hygienists in their practice of dentistry.

**Methodology**

The study targeted all empirical research, case studies, and systematic literature reviews written in English. Letters to editors, conference proceedings, and policy statements were not considered. Articles were retrieved using search engines e.g., Ebscohost, PubMed, and Google Scholar. Only articles published within a 15-year time period of 2001 and 2016 were included for review. The keywords/phrases included occupational health among dentists/dental therapists/hygienists, musculoskeletal problems among dentists/dental therapists/hygienists, risk factors for occupational health in dentistry, eye/sight/ear problems in dentistry, dental occupational health, and occupational health among oral hygienists and dental therapists.

The titles, keywords, and abstracts of articles were considered for potential relevance, and the full articles were obtained for those articles deemed to be relevant (Fig. 1). The articles were then subjected to data extraction and critical analysis through the use of a data extraction sheet. The extraction sheet was piloted on five articles, and adjustments were made. The authors, study designs, participants, locations, interventions, prevalences, outcomes, and conclusions were recorded in the electronic data extraction sheet. All of the extracted data were then incorporated into an Excel spreadsheet to identify common themes. Data extraction was done independently by two reviewers, and consensus was reached on the inclusion of manuscripts.

**Results**

The results are presented in a table format so as to summarize the methods, prevalence data, outcomes, and recommendations. The literature addressing occupational health among dental practitioners includes mainly cross-sectional studies and review papers. Most of the literature (90%) addresses MSDs among dentists, with limited literature covering occupational health or MSDs among oral hygienists and dental therapists. The selected studies focused on the prevalence of occupational health-related problems and not on the intervention to potentially address the particular issue. Forty-nine studies were included in the review and were selected after an initial electronic search through keywords (Table 1). The results are presented as the prevalence of stress, burnout, musculoskeletal disease (back, neck, hands, and shoulders, etc.), vision-related occupational health-related problems, percutaneous injury (PCI), noise, mercury-related occupational health issues, allergy, and infections. The outcomes and recommendations of the studies were included (Table 1).
| Title/Reference                                                                 | Sample          | Design                  | Prevalence               | Outcome                                                                 | Recommendations                                                                 |
|--------------------------------------------------------------------------------|-----------------|-------------------------|--------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Work-related musculoskeletal disorders in Australian dentists and orthodontists: Risk assessment and prevention \(^{9}\) | 450 dentists   | Cross sectional study   | 88.9%-dentists           | Less than1/3 received ergonomics training.                                | Musculoskeletal problems which were associated with increased levels of stress at work. More research into interventions. |
| Relationship between Comorbid Health Problems and Musculoskeletal Disorders Resulting in Musculoskeletal Complaints and Musculoskeletal Sickness Absent among Employees in Korea \(^{10}\) | 29,711 workers | Cross sectional study   | 32.26%-muscular pain     |                                                                          | For management of musculoskeletal complaints in the workplace, differences in health problems between employees with musculoskeletal complaints as well as the physical and psychological risk factors should be considered. |
| Evaluation of musculoskeletal disorders in dentists and application of DMAIC technique to improve the ergonomics at dental clinics and meta-analysis of literature \(^{11}\) | 60 dentists    | Cross sectional study intervention   | 68.3%-MSD              | After three months only 23 respondents applied ergonomics at their work place, prevalence of pain was reduced in neck from 47.8% to 21.7% out of total 23 respondents, shoulder pain 39.1% to 17.3%, pain in elbows from 26% to 21.7%, as well as in other locomotor organs. The p-value was significant with p<0.05. | The outcome highlights the need of workshops to create awareness of ergonomics as effective measures for reducing MSD among dentists. |
| Prevalence of musculoskeletal disorder and alternative medicine therapies among dentists of North India: A descriptive study \(^{12}\) | 3598 dentists  | Cross sectional study   | 80%-MSD                 | Complementary and alternative medicine was remarkably good for MSD management. | Complementary and alternative medicine should be scientifically tested to establish those that work. Randomised control trial should be conducted to establish efficacy. |
| The relationship between physical load and musculoskeletal complaints among Brazilian dentists \(^{13}\) | 340 dentists   | Cross sectional study   | 58.4%-lower back         | Pain complaints were associated with the following characteristics: awkward posture at work; prolonged standing or sitting; strenuous position of the upper limbs; excessive tightening of the hands during clinical treatment; and the use of vibrating tools. | The results of the present study suggest a high prevalence of musculoskeletal complaints in dentists that are significantly associated with variables related to their physical workload. |

| Table 1. Results |

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\(^{9}\) Rajeshree Moodley, et al.: Occupational health problems in dentistry

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Table 1. Results (continued)

| Title/Reference                                                                 | Sample | Design          | Prevalence                                                                 | Outcome                                                                 | Recommendations                                                                                       |
|--------------------------------------------------------------------------------|--------|-----------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Stress among dentists in Yemen \(^1\)                                            | 368 dentists | Cross sectional study | The most prevalent factors that contribute to stress were uncooperative patients (72.3%), amount of work (too much, too little) (60.5%) and constant drive for technical perfection (54.6%). | Stress was reflected in dentists with the signs being musculoskeletal fatigue in 63% and nervousness in 57.1%. | Praying and reading the Quran was reported by over two thirds (70.6%) of the participants to manage stress. Dentists with less than 30 years of experience displayed more stress. Lack of experience, low income, uncooperative patients, and dental procedure-related factors were the main significant factors that caused stress. |
| Occupational mercury exposure in association with prevalence of multiple sclerosis and tremor among US dentists \(^5\) | 13902 dentists | Investigative | 0.18% reported MS and 1.24% reported tremor. | Hg0 exposure was not associated with MS | Occupational Hg0 exposure in US dentists decreased over time and now is approaching that of the general population. Our results suggest a positive association between Hg0 exposure and tremor. |
| Prevalence of Upper Extremity Musculoskeletal Disorders in Dentists: Symptoms and Risk Factors \(^1\) | 130 dentists | Descriptive, Cross sectional study | 55.9%-neck 43.8%-shoulder 39.2%-waist 34.5%-wrist 32.5%-back | 15% of the subjects had to leave their clinic or reduce their work hours, and overall 68.9% of the subjects reported that they had experienced pain and discomfort at least once over the last year | High pain frequency and high risk levels suggest inappropriate and incorrect ergonomic postural habits existing among dental professionals. Male dentists are at risk of developing musculoskeletal disorders in the neck and upper extremities more than male pharmacists. |
| Neck and upper extremity symptoms among male dentists and pharmacists \(^7\) | 252 dentists | Cross sectional study | 76.2%-neck or hands | | |
| Occupational Hazards among Dentists: A Descriptive Study \(^9\) | 66 dentists | Cross sectional study | 83.3%-neck pain 9%-Allergy 59%-PCI 42.2%-stress | | MSD most common problem and ergonomics not featured in dental curricular in India. Continuing dental education programmes should include education regarding ergonomics, new materials, operating methods, new laws, vaccination. |
| Prevalence of work-related musculoskeletal symptoms of the neck and upper extremity among dentists in China \(^9\) | 272 dentists | Cross sectional study | 88%-MSD 83.8%-Neck | Regular physical exercise was associated with decreased neck pain As for psychosocial factors, high job demand was associated with symptoms in the shoulder Working hours per day were associated with neck pain | Primary prevention Early intervention Continuous education |
| Title/Reference | Sample | Design | Prevalence | Outcome | Recommendations |
|-----------------|--------|--------|------------|---------|-----------------|
| Design and evaluation of ergonomic interventions for the prevention of musculoskeletal disorders in India | 601 dentists | Cross sectional study | 82%-MSD | Proper implementation of ergonomic interventions can improve the economy of the nation | The cause for concern is that most of the interventions are not properly designed |
| Use of complementary and alternative medicine for work related musculoskeletal disorders associated with job contentment in dental professionals: Indian outlook | 264 dentists who are post graduate students | Cross sectional study/observational | 49%-MSD | Dentists who do not suffer from MSD experience higher job satisfaction. | Dentists who use CAM therapies for the prevention and management of WRMSD may experience higher job satisfaction and longevity than those who use conventional therapies |
| Work Characteristics and musculoskeletal disorders among Postgraduate Dental Students: A Pilot Study | 338 dentists | Cross sectional study | 79.9% - Neck, 72.4% - Shoulders, 69.8% - Lower back, 54.5% - Upper back, 24% - Hips/thighs, 27.4% - Knees, 19.6% - Ankles/feet, 49.7% - Wrist/hands | Correlation between body mass and pain | Special attention should be paid to the design of the working environment in faculties conforming to ergonomic principles |
| Ergonomics and musculoskeletal disorder: As an occupational hazard in dentistry | 170 dentists | Cross sectional study | 73.9%-MSD | 59.3% were aware of ergonomics | Musculoskeletal disorders may substantially affect the over-all well-being of the dentist. Dentistry is a profession that is prone to burnout with low energy and motivation |
| Occupational health problems among dentists in Moldavian Region of Romania | 152 dentists | Cross sectional study | 91%-exposed to an occupational risk. 41.8%-percutaneous injury caused by sharp instruments in the last year. 49.3%-eye injuries caused by solid particles 13.2%-blood splashes. 14.7% and/or chemicals | It suggested that ergonomics should be covered in the educational system to reduce risks to dental practitioners. Musculoskeletal complaints may have connection with general health. One must pay attention with one’s nutrition and exercise | The dental staff must be informed in order to recognize, control and prevent the potential occupational hazards in the workplace |
### Table 1. Results (continued)

| Title/Reference | Sample | Design | Prevalence | Outcome | Recommendations |
|-----------------|--------|--------|------------|---------|-----------------|
| Dental ergonomics to combat musculoskeletal disorders: A review 21 | 624 hygienists | Cross sectional study | 84.9%-neck<br>69.7%-shoulder<br>68%-lower back<br>61.8%-upper back<br>60.1%-hand | An interdisciplinary approach is necessary to address the concern, and progressive efforts should be taken to prevent MSDs in dental professionals. The problems start at undergraduate level therefore interventions should begin there. | Promoting training on both ergonomics (biomechanics) and stress reduction (psychosocial and physical) in dental schools as a prevention strategy |
| Musculoskeletal disorders and symptom severity among Australian dental hygienists 20 | Study on job postures and musculoskeletal illnesses in dentists 27 | 65 dentists | Cross sectional and observational | 75.9%-neck<br>58.6%-shoulder<br>56.9%-upper back<br>48.3%-lower back<br>44.8%-wrist | Job analysis by the use of Rapid Entire Body Assessment (REBA) showed that 89.6% of limbs in group A and 79.3% of limbs in group B had a score >4. Only neck and lower back pain have significant relationship with the risk levels obtained using the REBA method. |
| Occupational health problems of dentists in the United Arab Emirates 20 | 733 dentists | Cross sectional study | 68%-MDSD<br>42%-PCI<br>18%-contact dermatitis<br>53%-eye<br>5%-hearing | Awareness of occupational health problems should be highlighted in all research and clinical congresses. Further studies into the interventions to reduce prevalence | |
| Musculoskeletal disorders and ergonomic risk factors in dental practice 20 | Review | Reports of musculoskeletal symptoms among dental professionals are conspicuously high and manifested mainly as neck, shoulder, hand, arm, wrist and low back pain. | | Principles of ergonomics and design can be applied to workstations so that there are more neutral workstations. Job rotations and work planning can be introduced to prevent cumulative MSD. Dental training to improve ergonomics. Introduce micro breaks Introduce flexibility and strengthening exercises | |
| Prevalence of musculoskeletal disorders among dentists in Kerman, Iran 30 | 118 dentists | Cross sectional study | 46.4%-neck<br>33.8%-Wrist<br>28.8%-back<br>27.5%-shoulder | Further research into causes of MSD Knowledge of scope of ergonomics should be disseminated. Health and safety measures should be researched and shared | |
| Title/Reference | Sample | Design            | Prevalence | Outcome                                      | Recommendations                                      |
|----------------|--------|------------------|------------|----------------------------------------------|-----------------------------------------------------|
| Occupational health issues of oral health care workers in Edo State, Nigeria | 90 dentists, dental therapists, assistants and technologists | Cross sectional study | 66.7%-wrist pain, 76.7%-waist pain, 84.4%-body pain, 6.6%-infection, 17.8%-latex allergy | MSD was the predominant occupational health problem and the potential impact requires urgent educational and ergonomic intervention | The symptoms of MSDs increased with the number of years of practice |
| Work-related musculoskeletal disorders among dentists-a questionnaire survey | 220 dentists | Cross sectional study | 92%-MSD, 47%-neck, 35%-lower back, 29%-fingers, 23%-hip, 20%-mid back, 20%-shoulders, 18.3%-knees | 63.3%-no assistant, 33% worked with no break, 36.4% had one break, More females experienced pain in the fingers/males had more lower back symptoms, Significant relationships were found between MSDs and both standing work position and non-use of rest breaks, Risk factors were poor posture. | Innovations for an ergonomically friendly dental equipment would probably improve the work practice and therefore the health of dental personnel |
| Prevalence and associated factors of back pain among dental personnel in the north eastern state of Malaysia | 350 dentists, nurses and technicians | Cross sectional study | 44.9% back pain | 3.8%-work activities interrupted health problems | Dentists are at higher risk to develop musculoskeletal disorders, especially back pain, arthritis, and tendonitis, than the general population |
| Musculoskeletal disorders among Brazilian dentists | 298 dentists | Cross sectional study | 22.2%-back pain | Females reported more back pain and less shoulder pain than males, Neck, shoulder and back pain were significantly increased among older dentists and dentists with more years of professional experience | Need for further training and continuing education |
| Risk factors and prevalence of musculoskeletal disorders among Jordanian dentists | 200 dentists | Interviews | 86%-MSD, 56%-back, 47%-neck, 26%-wrist | The participants who did stretching or other preventive actions between patients suffered lesser low back pain. | MSD is common among dentists with higher incidence among women. The neck is the most affected. Oral surgeons showed a higher incidence of neck pain |
| Ergonomics and musculoskeletal pain among postgraduate students and faculty members of the School of Dentistry of the University of Barcelona (Spain). A cross-sectional study | 254 dentists | Cross sectional study | 79.8%-MSD, 58%-neck, 52.7%-lumbar area, 40.5%-back, 27.1%-wrist, 24.3%-shoulders | | |
| Title/Reference Sample | Design | Prevalence | Outcome |
|------------------------|--------|------------|---------|
| Glutathione enzyme and selenoprotein polymorphisms associate with mercury biomarker levels in Michigan dental professionals. | Cross-sectional study | 720 dentists | Occupational noise-exposure: increased hearing loss. |
| Self-reported occupational health of general dental practitioners. | Cross-sectional study | 1670 | 47%-dermatitis, 59%-neck pain, 57%-low back pain. |
| Self-reported occupational health issues among Lithuanian dentists | Cross-sectional study | 354 dentists | 45%-shoulders, 45%-lower back, 83.1%-hands. |
| Occupational burnout and work engagement amongst dentists who had additional professional qualifications, worked longer hours and worked in large group practices | Cross-sectional study | 700 dentists | 42%-time pressure, 42%-socio-emotional exhaustion, 43%-high levels of concentration. |
| Job stresses of New Zealand dentists and their coping strategies | Cross-sectional study | 247 dentists | 57%-eye protection in laboratory, 41%-eye protection compliance was low. |
| Title/Reference | Sample | Design | Prevalence | Outcome | Recommendations |
|-----------------|--------|--------|------------|---------|-----------------|
| The effect of tool handle shape on hand muscle load and pinch force in a simulated dental scaling task | 110 dentists | Cross sectional study | 55.2%-stress at work | The instrument handle with a tapered, round shape and a 10mm diameter required the least muscle load and pinch force when performing simulated periodontal work. | Modify work practice by rescheduling patients with heavy calculus, taking breaks and using sharp instruments. This will reduce MSD of the upper extremities |
| Outcome of career expectancies and early professional burnout among newly qualified dentists | 380 dentists | Cross sectional study | 54%-low back pain, (stress-correlated); 52.3%-vision problems, (age-correlated) 9%-infections 22.5%-allergies, (mainly latex) 7-stress level was scored on a scale from 0 to 10; 6%-diminished sensitivity of the fingertips 19.6%-auditory disorders | Pilot audiometric data showed a hearing loss at 4,000 Hz for the left ear, indicative of occupational noise trauma. The two-point discrimination ability of the dominant hand tended to diminish in line with the number of years of practice. | Practice management is the professional aspect about which young professionals worry most. It is recommended that dental schools pay attention to practice management skills and the stressfulness of work in the curriculum |
| Potential occupational health problems for dentists in Flanders, Belgium | 10 dentists | Cross sectional study and investigative | Statistical correlation was found between blood mercury levels and the duration of time working in dental offices (r=0.01); this ranged from 5 to 9 years. | Mercury levels in whole blood were not high in exposed dentists, although it was reported that dentists have almost twice the concentration of mercury in their blood as non-dentists |
| Mercury Exposure in Dental Practice | 138 dentists and hygienists | Cross sectional study | 80%-wore eye protection 48%-experienced ocular trauma 96% of hygienists wore eye protection | Eye protection is sub optimal and it should in this environment |
| Eye safety in operative dentistry—A study in general dental practice | 57 dentists | Intervention Cross sectional study | The dentists saw a clear relation between their implementation of recommendations and a reduction in MSD; 72% of the dentists reported a reduction or disappearance of the main complaint. | Implementation of ergonomics decreases MSD. Creating guidelines for the implementation of ergonomics |
| Evaluation of ergonomic interventions to reduce musculoskeletal disorders of dentists in the Netherlands | | | | | |
| Title/Reference | Sample | Design                  | Prevalence | Outcome                                                                                                                                                                                                 | Recommendations                                                                 |
|----------------|--------|-------------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Visual impairment on dentists related to occupational mercury exposure 49) | 15 dentists | Cross sectional/comparative/investigative |            | Contrast sensitivity functions were also significantly affected in the group of dentists compared to the age-matched control group. They were uniformly reduced at all spatial frequencies examined for both luminance and chromatic (red-green and blue-yellow) contrasts. | Reduction in the use of mercury monitoring. Adoption of safety protection. Regular monitoring of dentists’ visual functions in order to evaluate the presence of very low-level mercury exposure. |
| Prevalence of musculoskeletal disorders in dentists 50) | 430 dentists | Cross sectional study | 62%-MSD   | The physical load among dentists seems to put them at risk for the occurrence of musculoskeletal disorders.                                                                                             | Psychosocial aspects should be taken into account when investigating MSD.          |
| Mercury vapour levels in dental practices and body mercury levels of dentists and controls 51) | 180 dental surgeries | Cross sectional Investigative | Urinary mercury levels of dentists were 4 times higher than control | 80%-environmental mercury above occupational exposure standard | Greater emphasis is needed in the safe handling of mercury. Greater emphasis should be made relating to safe handling of amalgam in the training and continuing professional development of dentists. The prevalence of hand and finger symptoms in the dominant hand among dental hygienists in this study was high. Prevalence for CTS was nearly the same as the general population. Aerobic and relaxation exercise to prevent limitations and to increase productive years. Posture correction and weight monitoring. |
| Prevalence of Carpal Tunnel Syndrome and upper extremity tendinitis among dental hygienists 52) | 305 hygienists | Cross sectional Investigative | 28%-Carpal Tunnel Syndrome 7%-tendonitis |                                                                                                                                      |                                                                                   |
| Back & neck problems among dentists and dental auxiliaries 53) | 264 dentists | Interview and observation | 54.4%-neck pain 73.5%-back pain 37%-of those complaining of back pain sought medical help. | Venticing of aspirated waste air to the outside is clearly desirable in view of the findings of this report. | The safety of dental aspirators with respect to mercury emissions warrants further research. Further continuing education as a recommendation in the avoidance of PVA allergens. To identify appropriate intervention to reduce its prevalence. Further studies are needed to identify causes of musculoskeletal pain and to identify appropriate interventions to reduce its prevalence, as would similar measures to reduce exposure to agents which may be producing contact dermatitis. |
| Mercury vapour release from a dental aspirator 54) | Investigative | 10 times more air concentration of mercury vapour-25 μg/m3 is the current limit of occupational exposure | Venticing of aspirated waste air to the outside is clearly desirable in view of the findings of this report. |                                                                                                                                      |                                                                                   |
| Occupational health problems of dentists in southern Thailand 55) | 178 dentists | Cross sectional study | 78%-musculoskeletal pain 50%-percutaneous injury 22%-contact dermatitis mostly caused by allergy to latex gloves 15%-eye problems 3%-hearing problems. |                                                                                                                                      |                                                                                   |
Discussion

The prevalence of occupational health-related problems is a concern among dental practitioners, with MSDs, stress, and PCIs being the most prevalent problems. A number of studies have found that occupational health-related problems are on the increase, despite new and innovative equipment being developed and used in dental practice. Several studies showed that dental workers presented with at least one occupational hazard. To illustrate this, in the Moldavian region of Romania, the majority of dentists (91%) considered that they were exposed to at least one occupational risk. Biswas et al., in a review paper, concurred that musculoskeletal symptoms among dental professionals were conspicuously high and manifested mainly as neck, shoulder, hand, arm, wrist, and lower back pain. The capabilities of the dental worker, job demands, and improper work process and hand tool use impose strain on the musculoskeletal system. MSDs were the most common occupational health-related problems reported among dentists in the Edo State of Nigeria. These findings led the researchers to conclude that urgent education and ergonomic intervention are needed. This review showed that female dentists had a higher prevalence of occupational health-related problems compared with male dentists. Ayers et al. reported higher incidences of percutaneous injuries (PCIs) and MSDs among female practitioners, which places women at a higher risk of health problems.

Stress and burnout

Stress among dentists is prevalent, and this expresses a need for a stress management system. Practice and financial management are stressors among young dentists. The majority of dentists in the Puriene et al. study complained of burnout (94.7%), and 40.5% of those with burnout presented with chronic symptoms. A report of a study conducted in the UK stated that 42% of surveyed dentists displayed high scores of emotional exhaustion. Factors that caused stress among newly qualified dentists were those concerning legal and insurance matters (61.2%), practice organization (56.6%), and staff management (55.2%). The most common stressors reported for a New Zealand study were treating difficult children (52%), time pressures (48%), and maintaining high levels of concentration (43%). Stress (50%) and lapses in concentration and fatigue (32.9%) were the most common causes for needle-stick injury (NSI). To improve this situation, there is a need to look at dentistry curricula and to investigate whether each dentistry curriculum prepares students to manage a practice. Patients with fear present to dental practitioners and students. There is concern that undergraduate training does not prepare dentistry students to deal with fear in their patients. This leads to stress and anxiety. Alzahem et al. suggest that students should have access to psychologists to teach them how to deal with fear. Psychologists in a dental training context can also assist students with strategies to deal with their own fears, i.e., the fear of failing and dealing with their fears, and this in turn will assist the students to cope with fears in private practice. Strategies to cope with stress and burnout were identified as active coping, planning, religion, sports, forgetting about work, interaction with people, and acceptance.

Musculoskeletal disorders (MSDs)

The most common sites for MSDs were neck, lower back, and shoulders. Women showed a higher frequency of intense pain involving the cervical, lumbar, dorsal, and wrist areas (p < 0.05), placing them at a higher risk of injury. Although the study of Alexandre et al. reported a higher prevalence of complaints from male dentists about back pain, the authors reported that female dentists were at higher risk of tendinitis. The introduction of the principles of ergonomics in practice is suggested by many researchers. This is not consistent with the study conducted by Rafemanesh et al., where 60% of the participants were aware of correct ergonomic posture, yet nearly 74% of these dentists reported MSDs of the back and neck being the most painful. For that study, the researchers also reported that pain increased with age and time spent in clinical practice and that the specialty whose practitioners were at greatest risk was prosthodontics. The Rafie et al. study using both a cross-sectional survey and observation using rapid upper-limb assessment showed that 82.8% of the subjects were at risk of MSDs. Nearly 69% of the subjects in that study had experienced pain and discomfort over the preceding 12-month period, while 15% had to leave clinical work or reduce the hours worked due to MSD symptoms. The prevalence of hand and finger symptoms was high among dental hygienists, with a high rate of upper extremity tendinitis. The job-related activities of dental hygienists, including the use of vibratory tools and the repetitive nature of their work, places these practitioners at risk for MSDs of the hands. MSDs of the neck (85%), shoulder (70%), and lower back (68%) regions were frequently reported by dental hygienists. The information gathered from a study of Swedish dentists tended to put dentists at the higher end of the spectrum of healthcare professionals in terms of severity of musculoskeletal injury and lost work time. This emphasizes the need to educate newly qualified practitioners and students on musculoskeletal health. However, job posture analysis revealed that the extraction of the left and right lower jaw teeth, and also extraction of the right upper jaw teeth and restoration of the upper teeth, exacerbated the worst job postures. A higher incidence of wrist pain was recorded for professionals exclusively dedicated to oral sur-
gery (p < 0.05). No statistically significant correlation was found between the workload (hours) and pain in the different anatomical locations (p > 0.05).\(^\text{50}\) Despite the evidence of the occurrence of MSD pain caused by the work done by dental health workers, job posture analysis and workplace analysis are not carried out very often in dentistry. These forms of analysis should be carried out by new and old practitioners to remove risks in dental practice, thereby reducing the prevalence of MSDs.

**Vision-related occupational health issues**

Ocular hazards are common in dentistry.\(^\text{49}\) Extreme caution should be taken when performing clinical work. The most striking evidence reported from the Lönnroth & Shahnazav study is that few dentists use eye protection. The hazards reported in that study include injury from rotary instruments and chemical handling.\(^\text{49}\) Chadwick concluded that a limited use of eye protection exposed dentists to unnecessary occupational risks.\(^\text{42}\) The Canto-Pereira et al. study investigated visual impairment and occupational exposure to mercury among dentists and found that visual color discrimination and contrast sensitivity were indicators of a subtle neurotoxic effect of elemental mercury.\(^\text{46}\) The use of mercury in Nordic countries is banned, with other countries proposing the phasing down of amalgam use until an amalgam replacement can be found. Visits to ophthalmologists should be regular, as dental work impacts vision, yet Chadwick et al. found that dentists with known eyesight problems were the only ones who presented for regular eye examinations. The study also found that the use of magnification was not universally adopted and that eye protection compliance was low.\(^\text{42}\) Magnification enhances vision, preventing dental practitioners from bending their necks, thereby decreasing the chances of developing MSDs.

**Percutaneous injury (PCI)**

In Southern Thailand, PCI was experienced by 50% of dentists, while 41.8% of dentists in the United Arab Emirates (UAE) experienced at least one PCI in the previous year.\(^\text{55,56}\) In a German study, 61.7% of dentists sustained at least one NSI. The injuries were caused by surgical devices (46.2%), needles (25.4%), and scalpels (14.2%). Only a few injuries were due to bite wounds (3.6%), skin contact (0.6%), and mucocutaneous contact (6.5%).\(^\text{49}\) Wicker & Rabenau and Legatt et al. concurred that students and younger dentists were at risk of PCIs.\(^\text{45,62}\) This demonstrates the importance of education programs for younger dentists and vigilant supervision of dental students.

**Noise**

More studies need to be conducted into the effects of noise on the dental worker. Noise in dental training is significant, and this is highlighted by Sampaio Fernandes et al., who stated that the noisiest area is the gypsum and prosthetic laboratory, followed by the preclinical area. They further described clinical areas as having continuous high noise levels, especially for clinical supervisors and students. According to their research, the minimal acoustic comfort level is required in a dental setting and, to achieve this, sound levels have to be reduced by at least 10 dB(A).\(^\text{63}\) Szymanska and Chopra & Pandey concurred that the noise of the suction devices, salivary ejectors, turbines, amalgamators, model trimmers, mixing devices, ultrasonic scalers, and compressors causes impaired hearing.\(^\text{46,64}\) Occupational noise is the most common cause of hearing loss in adults. Noise-induced hearing loss is irreversible, as there is damage to the cochlear hair cells of the inner ear and if staff and students are in a skills lab where there is constant noise then they are exposed to irreparable damage to their ears. Given that mercury exposure affects the auditory senses, dentists and dental therapists who are exposed to dental amalgam from the time of undergraduate training and throughout practice are at greater risk due to long-term use.\(^\text{75}\) Additional risks are the quality of hand pieces used in dental training and practice, which differs for different manufacturers, and so does the associated noise level. Newly qualified dental practitioners order equipment on the basis of funding and affordability rather than looking at the noise levels. Surgery design is an important factor in the reduction of noise.\(^\text{76}\) Furthermore, noise reduction in a dental setting is needed for both patient and operator comfort.

**Mercury-related occupational health-related problems**

Mercury exposure as measured in the dental operatory zone was found to be 10 times greater than the acceptable exposure levels after 20 minutes of aspiration; this is due to the corrugated tubing that traps amalgam.\(^\text{16}\) A significant difference was reported between the level of urinary mercury of Scottish dentists and that of a control group, with the levels of dentists being 4.17 times higher in a Scottish study.\(^\text{37}\) In a study conducted by Atesagaolu et al., mercury levels in whole blood were not high among the dentists, although this was not the case in other studies. The methyl mercury level was higher than mercury in blood, and the authors concluded that mercury from other sources was a greater risk than the mercury found in amalgam.\(^\text{46}\) There was a positive association between mercury exposure and tremors among American dentists.\(^\text{46}\) Dental operators were found to have a significantly higher hair mercury level than non-dentists in a Michigan study.\(^\text{76}\) Dental students in a restorative clinic work with dental amalgam and are exposed to mercury from 1st to 5th year. This exposure is a source of blood mercury, as mercury crosses the pulmonary membrane and reaches the blood stream. Improvement of mercury hygiene and technical equipment can reduce exposure to mercury. The curriculum of restorative dentistry includes mercury han-
duling and care, but there is a need to include this topic in clinical and preclinical training and in continuous professional development activities⁶⁷.

Mercury vapor inhaled by dental operators is retained in the brain, endocrine organs, and other tissues. Cutright et al., as cited by Guzzi et al., stated that there was a positive correlation between inhaled mercury dust and deposition of the inhaled mercury in blood and tissues⁶⁸. This reveals the need for a phase-down approach to amalgam use and the corresponding increased use of amalgam alternatives.

Allergy
Allergy, mainly latex related (22.5%), was reported among dentists from Belgium where potential occupational health problems were investigated⁶⁹. A latex allergy presents as pruritus, urticaria, eczema, and asthma. Almost half the sample of dentists (47%) had experienced a dermatitis-type condition in the previous 12 months in New Zealand⁷⁰. Allergies associated with professional activity were reported by 76.1% of the dentists in the UAE⁷¹. Dentistry is regarded as “wet work” which may damage the skin barrier and lead to exposure to skin irritants and sensitivity to components in gloves. Airway irritants may also be present in the work environment of dental workers⁷². Dental students are intensive users of gloves, which places them at risk of latex allergies. The type of gloves used in training is central to sensitization rates and latex-allergy symptoms. Low-protein non-powdered gloves reduce exposure to the latex allergen⁷³.

Infection
Belgian dentists (9%) reported infections related to dentistry⁷⁴. In the UAE, 74.6% of dentists are protected by vaccination against Hepatitis B and 76.1% against influenza⁷⁵. PCIs due to the small operating field, patient movement, and the variety of sharp instruments used on a daily basis are greater in a dental setting and teaching environment when compared with those in other healthcare settings. This exposes dental staff to HIV and Hepatitis B and Hepatitis C viruses. A hands-on approach in the students’ learning process and the introduction of safer products and clinical procedures should form part of the curriculum to protect the student⁷⁶.

A limitation to this review includes the number of articles selected and the fact that articles written only in English were selected.

Conclusion
This review shows that occupational health-related problems still affect dental workers, with MSDs being the most frequent problem. More research is being conducted among dentists than among dental therapists and oral hygienists, with great gaps about factors affecting the health of dental therapists and oral hygienists. The prevalence and the investigative studies highlight the need for continuous professional education and a need to review dentistry curricula at a tertiary level.

Further research is required, where stresses and strains are measured while dental workers carry out their normal duties, and interventions need to be identified to reduce the prevalence of MSDs. More studies are needed in the occupational hearing-impairment area. Mercury handling should be made safer, and it is imperative that newer and safer dental materials be introduced from the level of undergraduate training and throughout practice.

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