

Review

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

Rajeshree Moodley<sup>1</sup>, Saloshni Naidoo<sup>2</sup> and Jacqueline van Wyk<sup>3</sup>

<sup>1</sup>Discipline of Dentistry, School of Health Sciences, University of KwaZulu-Natal, Durban, KwaZulu-Natal, South Africa, <sup>2</sup>Discipline of Public Health Medicine, School of Nursing and Public Health, University of KwaZulu-Natal, Durban, KwaZulu-Natal, South Africa and <sup>3</sup>Discipline of Clinical and Professional Practice, School of Clinical Medicine, College of Health Sciences, University of KwaZulu-Natal, Durban, KwaZulu-Natal, South Africa

**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.

(J Occup Health 2018; 60: 111-125)

doi: 10.1539/joh.17-0188-RA

**Key words:** Musculoskeletal disorders, Occupational health, Percutaneous injury, Stress

### Introduction

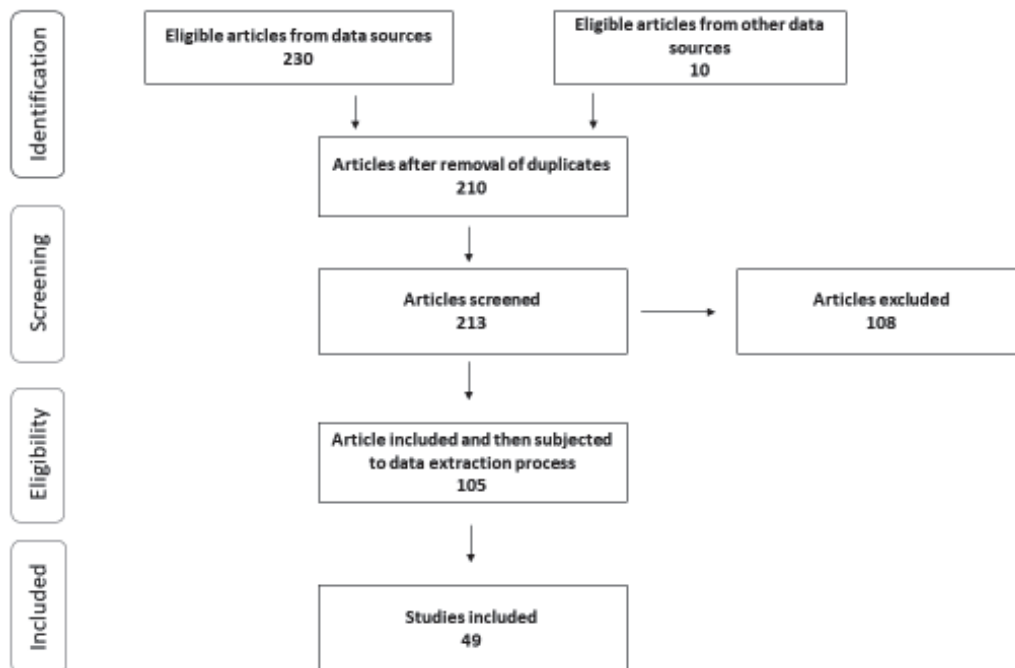
Dental practitioners in dentistry training and practice environments are challenged with a number of occupational health barriers. The dental worker is prone to physical and psychological stressors which are aggravated by the work environment<sup>1</sup>. Irrespective of where one works, the goal is 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 goals<sup>2</sup>. 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 lives<sup>3</sup>.

Dental workers are prone to occupational health-related problems occupational health problems, with dental hazards being of a physical, biological, chemical, and psychosocial nature<sup>4</sup>. Musculoskeletal disorders (MSDs), eye injuries, vibration-induced neuropathy, and psychological conditions are some of the poor health outcomes due to occupational health issues<sup>5</sup>. 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 materials<sup>6</sup>. The prevention of such injuries should be included in educa-

Received July 19, 2017; Accepted November 13, 2017

Published online in J-STAGE December 6, 2017

Correspondence to: R. Moodley, Discipline of Dentistry, School of Health Sciences, University of KwaZulu-Natal, University Rd Reservoir Hills 4000, Durban, South Africa (e-mail: moodleyra@ukzn.ac.za)



**Fig. 1.** Diagram of the search strategy

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 ex-

traction 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<sup>7,8)</sup>.

## 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).

Table 1. Results

Title/Reference	Sample	Design	Prevalence	Outcome	Recommendations
Work-related musculoskeletal disorders in Australian dentists and orthodontists: Risk assessment and prevention <sup>9)</sup>	450 dentists 447 orthodontists	Cross sectional study	88.9%-dentists 83.6%-orthodontists	Less than 1/3 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 Absence among Employees in Korea <sup>10)</sup>	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 <sup>11)</sup>	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 <sup>12)</sup>	3598 dentists	Cross sectional study Intervention by complementary and alternative medicine	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 <sup>13)</sup>	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 (continued)

Title/Reference	Sample	Design	Prevalence	Outcome	Recommendations
Stress among dentists in Yemen <sup>14)</sup>	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 <sup>15)</sup>	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 <sup>16)</sup>	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
Neck and upper extremity symptoms among male dentists and pharmacists <sup>17)</sup>	252 dentists	Cross sectional study	76.2%-neck or hands		Male dentists are at risk of developing musculoskeletal disorders in the neck and upper extremities more than male pharmacists
Occupational Hazards among Dentists: A Descriptive Study <sup>18)</sup>	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 <sup>4)</sup>
Prevalence of work-related musculoskeletal symptoms of the neck and upper extremity among dentists in China <sup>19)</sup>	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 paina	Primary prevention Early intervention Continuous education

Table 1. Results (continued)

Title/Reference	Sample	Design	Prevalence	Outcome	Recommendations
Design and evaluation of ergonomic interventions for the prevention of musculoskeletal disorders in India <sup>20</sup>		Case study		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 <sup>21</sup>	601 dentists	Cross sectional study	82%-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 <sup>22</sup>	264-dentists who are post graduate students	Cross sectional study/observational	49%-MSD 34% lower back 26%-neck 20%-upper back	Correlation between body mass and pain Females displayed more pain than males	Special attention should be paid to the design of the working environment in faculties conforming to ergonomic principles
Self-reported musculoskeletal pain among dentists in South Africa: A 12-month prevalence study <sup>23</sup>	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%- Wrists/hands		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
Ergonomics and musculoskeletal disorder: As an occupational hazard in dentistry <sup>24</sup>	170 dentists	Cross sectional study	73.9%-MSD 31.7%-Neck 18.9%-Shoulder 7.2%-Arms 29.2%-Back 13%-Hands	59.3%-were aware of ergonomics	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
Occupational health problems among dentists in Moldavian Region of Romania <sup>25</sup>	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		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 <sup>2)</sup>		Review paper		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 <sup>26)</sup>	624 hygienists	Cross sectional study	84.9%-neck 69.7%-shoulder 68%-lower back 61.8%-upper back 60.1%-hand		MSD is a common problem that requires medical attention. Further research into the epidemiology, risk factors, and impact on employment
A study on job postures and musculoskeletal illnesses in dentists <sup>27)</sup>	65 dentists	Cross sectional and observational	75.9%-neck 58.6%-shoulder 56.9%-upper back 48.3%-lower back 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.	Work postures of dentists need to improve Education, work station design, rest period during work and regular physical activities should be taken into account
Occupational health problems of dentists in the United Arab Emirates <sup>28)</sup>	733 dentists	Cross sectional study	68%-MSD 42%-PCI 18%-contact dermatitis 53%-eye 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 <sup>29)</sup>		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 <sup>30)</sup>	118 dentists	Cross sectional study	46.4%-neck 33.8%-Wrist 28.8%-back 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

Table 1. Results (continued)

Title/Reference	Sample	Design	Prevalence	Outcome	Recommendations
Occupational health issues of oral health care workers in Edo State, Nigeria <sup>31)</sup>	90 dentists, dental therapists, assistants and technicians	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
Work-related musculoskeletal disorders among dentists-a questionnaire survey <sup>32)</sup>	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.	The symptoms of MSDs increased with the number of years of practice
Prevalence and associated factors of back pain among dental personnel in the north eastern state of Malaysia <sup>6)</sup>	350 dentists, nurses and technicians	Cross sectional study	44.9% back pain		Innovations for an ergonomically friendly dental equipment would probably improve the work practice and therefore the health of dental personnel
Musculoskeletal disorders among Brazilian dentists <sup>33)</sup>	298 dentists	Cross sectional study	22.2%-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 Need for further training and continuing education
Risk factors and prevalence of musculoskeletal disorders among Jordanian dentists <sup>34)</sup>	200 dentists	Interviews	86%-MSD 56%-back 47%-neck 26%-wrist	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	
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 <sup>35)</sup>	254 dentists	Cross sectional study	79.8%-MSD 58%-neck 52.7%-lumbar area 40.5%-back 27.1%-wrist 24.3%-shoulders	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

Table 1. Results (continued)

Title/Reference	Sample	Design	Prevalence	Outcome	Recommendations
Glutathione enzyme and selenoprotein polymorphisms associate with mercury biomarker levels in Michigan dental professionals <sup>36)</sup>	515 dental professionals	Cross sectional Survey/investigative	Dentists had significantly higher hair mercury levels compared to non-dentists.		While dentists' occupational exposures are higher than the average population, a shift toward use of composite resin fillings and safer handling of mercury may result in dentists having urine biomarker levels comparable to that of the general population
Occupational noise-induced hearing loss <sup>37)</sup>		review			Hearing conservation program (decrease source and level of noise) Providing free protective devices and training to be given on proper use Should be a permissible exposure level In a high noise environment-a 12 hour shift should be followed by a day off. Performing periodic hearing appraisals Pregnant women-exposure to noise-affects the hearing of the unborn child
Self-reported occupational health of general dental practitioners <sup>38)</sup>	750 dentists	Cross sectional study	47%-dermatitis 59%-neck 57%-lower back 45%-shoulders	Female higher prevalence than male 19%-workplace bullying	The prevalence of musculoskeletal problems and dermatoses was high and impacted significantly on the daily lives of dentists
Self-reported occupational health issues among Lithuanian dentists <sup>39)</sup>	1670 dentists	Cross sectional study	91%-Back pain 57.1%-back pain 83.1%-hanks	94.7%-burnout	Early treatment and diagnosis Increased knowledge of dental workers
Occupational burnout and work engagement: a national survey of dentists in the United Kingdom <sup>40)</sup>	354 dentists	Cross sectional study	42%-emotional exhaustion 8%-burnout on all 3 scales	Higher levels of work engagement were found amongst dentists who had additional professional qualifications, worked longer hours and worked in large group practices.	Assessing impact of patient care is critical
Job stressors of New Zealand dentists and their coping strategies <sup>41)</sup>	700 dentists	Cross sectional study	52%-treating children as a stressor 48%-time pressure 43% high levels of concentration	Work stress relieving factors were exercise, forgetting about work and interaction with people	Cope using active coping strategies
Eye care habits of dentists registered in the United Kingdom <sup>42)</sup>	247 dentists	Cross sectional study	57%-eye protection in laboratory	Eye protection compliance was low	The need for eye protection in all clinics and labs. Bi annual eye tests



Table 1. Results (continued)

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 <sup>43)</sup>		Experimental		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 <sup>44)</sup>	110 dentists	Cross sectional study	55.2%-stress at work 45.1%-staff management		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 <sup>45)</sup>	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.	Further studies are required to provide more details on the risks for occupational hearing impairment and vibration hand neuropathy and to determine whether the problems described were related to the practice of dentistry
Mercury Exposure in Dental Practice <sup>46)</sup>	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
Eye safety in operative dentistry—A study in general dental practice <sup>47)</sup>	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 be in this environment
Evaluation of ergonomic interventions to reduce musculoskeletal disorders of dentists in the Netherlands <sup>48)</sup>	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

Table 1. Results (continued)

Title/Reference	Sample	Design	Prevalence	Outcome	Recommendations
Visual impairment on dentists related to occupational mercury exposure <sup>49)</sup>	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 <sup>50)</sup>	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 <sup>51)</sup>	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
Prevalence of Carpal Tunnel Syndrome and upper extremity tendinitis among dental hygienists <sup>52)</sup>	305 hygienists	Cross sectional Investigative	28%-Carpal Tunnel Syndrome 7%-tendonitis		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
Back & neck problems among dentists and dental auxiliaries <sup>53)</sup>	264 dentists	Interview and observation	54.4%-neck pain 73.5%-back pain 37%-of those complaining of back pain sought medical help.		Aerobic and relaxation exercise to prevent limitations and to increase productive years Posture correction and weight monitoring
Mercury vapour release from a dental aspirator <sup>54)</sup>		Investigative	10 times more air concentration of mercury vapour-25 µg/m <sup>3</sup> is the current limit of occupational exposure	Venting 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
Occupational health problems of dentists in southern Thailand <sup>55)</sup>	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.		Further continuing education as a recommendation in the avoidance of PI/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

## 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<sup>25,31</sup>. 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<sup>25</sup>. 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<sup>29</sup>. 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<sup>31</sup>. This review showed that female dentists had a higher prevalence of occupational health-related problems compared with that of male dentists<sup>22,32,34,38</sup>. 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<sup>38</sup>.

### *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<sup>56</sup>. 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<sup>39</sup>. A report of a study conducted in the UK stated that 42% of surveyed dentists displayed high scores of emotional exhaustion<sup>40</sup>. 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%)<sup>44</sup>. 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%)<sup>41</sup>. Stress (50%) and lapses in concentration and fatigue (32.9%) were the most common causes for needle-stick injury (NSI)<sup>57</sup>. 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<sup>56</sup>. 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 burn-out were identified as active coping, planning, religion, sports, forgetting about work, interaction with people, and acceptance<sup>41,58</sup>.

### *Musculoskeletal disorders (MSDs)*

The most common sites for MSDs were neck, lower back, and shoulders<sup>38</sup>. 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<sup>35</sup>. 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 tendonitis<sup>33</sup>.

The introduction of the principles of ergonomics in practice is suggested by many researchers<sup>2,4,11,24,29,30,48</sup>. This is not consistent with the study conducted by Rafeemanesh 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<sup>27</sup>. 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<sup>27</sup>. 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<sup>16</sup>. The prevalence of hand and finger symptoms was high among dental hygienists, with a high rate of upper extremity tendonitis<sup>59</sup>. 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<sup>26</sup>. 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<sup>60</sup>. 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<sup>27</sup>. 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 ( $p > 0.05$ )<sup>35</sup>. 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<sup>61</sup>. Extreme caution should be taken when performing clinical work. The most striking evidence reported from the Lönnroth & Shahnavaz study is that few dentists use eye protection. The hazards reported in that study include injury from rotary instruments and chemical handling<sup>61</sup>. Chadwick concluded that a limited use of eye protection exposed dentists to unnecessary occupational risks<sup>42</sup>. 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<sup>49</sup>. 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<sup>42</sup>. 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<sup>25,55</sup>. 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 muco-cutaneous contact (6.5%)<sup>57</sup>. Wicker & Rabenau and Leggat et al. concurred that students and younger dentists were at risk of PCIs<sup>57,62</sup>. 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 dBa<sup>63</sup>. 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<sup>64,65</sup>. 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<sup>37</sup>. 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<sup>64</sup>. 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<sup>54</sup>. 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<sup>51</sup>. In a study conducted by Atesagaoglu 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<sup>46</sup>. There was a positive association between mercury exposure and tremors among American dentists<sup>66</sup>. Dental operators were found to have a significantly higher hair mercury level than non-dentists in a Michigan study<sup>36</sup>. 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-

ding and care, but there is a need to include this topic in clinical and preclinical training and in continuous professional development activities<sup>67</sup>.

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 tissues<sup>68</sup>. 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 investigated<sup>45</sup>. 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 Zealand<sup>38</sup>. Allergies associated with professional activity were reported by 76.1% of the dentists in the UAE<sup>25</sup>. 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 workers<sup>69</sup>. 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 allergen<sup>45</sup>.

### Infection

Belgian dentists (9%) reported infections related to dentistry<sup>45</sup>. In the UAE, 74.6% of dentists are protected by vaccination against Hepatitis B and 76.1% against influenza<sup>25</sup>. 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 student<sup>70</sup>.

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.

*Conflicts of interest:* None declared.

### References

- 1) Puriene A, Janulyte V, Musteikyte M, et al. General health of dentists. Literature review. *Stomatologija* 2007; 9(1): 10-20.
- 2) Gupta A, Ankola AV, Hebbal M. Dental ergonomics to combat musculoskeletal disorders: a review. *International Journal of Occupational Safety and Ergonomics* 2013; 19(4): 561-571.
- 3) WHO. Global strategy on occupational health for all: the way to health at work, recommendation of the Second Meeting of the WHO Collaborating Centres in Occupational Health, 11-14 October 1994, Beijing, China. 1995.
- 4) Reddy V, Bennadi D, Satish G, et al. Occupational hazards among dentists: A descriptive study. *Journal of Oral Hygiene & Health* 2015; 3(5): 1-4.
- 5) Leggat P, Kedjarune U, Smith DR. Occupational health problems in modern dentistry: A review. *Industrial Health* 2007; 45: 611-621.
- 6) Samat A, Shafei M, Yaacob N, et al. Prevalence and associated factors of back pain among dental personnel in the north eastern state of Malaysia. *International Journal of Collaborative Research on Internal Medicine and Public Health* 2011; 3: 576-586.
- 7) Dochy F. A guide for writing scholarly articles or reviews for the Educational Research Review. *Educational Research Review* 2006; 4: 1-2.
- 8) Cronin P, Ryan F, Coughlan M. Undertaking a literature review: a step-by-step approach. *British Journal of Nursing* 2008; 17(1): 38-43.
- 9) Sakzewski L, Naser-ud-Din S. Work-related musculoskeletal disorders in Australian dentists and orthodontists: risk assessment and prevention. *Work* 2015; 52(3): 559-579.
- 10) Baek JH, Kim YS, Yi KH. Relationship between comorbid health problems and musculoskeletal disorders resulting in musculoskeletal complaints and musculoskeletal sickness absence among employees in Korea. *Safety and Health at Work* 2015; 6(2): 128-133.
- 11) Bedi H, Moon NJ, Bhatia V, et al. Evaluation of musculoskeletal disorders in dentists and application of DMAIC technique to improve the ergonomics at dental clinics and meta-analysis of literature. *Journal of Clinical and Diagnostic Research* 2015; 9(6): ZC01.

- 12) Gupta D, Mathur A, Patil GI, et al. Prevalence of musculoskeletal disorder and alternative medicine therapies among dentists of North India: A descriptive study. *Pharmacognosy Research* 2015; 7(4): 350-354.
- 13) Dantas FFO, de Lima KC. The relationship between physical load and musculoskeletal complaints among Brazilian dentists. *Applied Ergonomics* 2015; 47: 93-98.
- 14) Al-Zubair NM, Sultan Al-ak'hali M, Ghandour IA. Stress among dentists in Yemen. *The Saudi Journal for Dental Research* 2015; 6(2): 140-145.
- 15) Anglen J, Gruninger SE, Chou HN, et al. Occupational mercury exposure in association with prevalence of multiple sclerosis and tremor among US dentists. *The Journal of the American Dental Association* 2015; 146(9): 659-668. e1.
- 16) Rafie F, Zamani Jam A, Shahravan A, et al. Prevalence of upper extremity musculoskeletal disorders in dentists: symptoms and risk factors. *Journal of Environmental and Public Health* 2015; 2015: 1-6.
- 17) Aminian O, Alemohammad ZB, Hosseini MH. Neck and upper extremity symptoms among male dentists and pharmacists. *Work* 2015; 51(4): 863-868.
- 18) Reddy V, Bennadi D, Satish G, et al. Occupational hazards among dentists: A descriptive study. *Journal of Oral Hygiene & Health* 2015; 3(185): doi: 10.4172/2332.0702.1000185.
- 19) Feng B, Liang Q, Wang Y, et al. Prevalence of work-related musculoskeletal symptoms of the neck and upper extremity among dentists in China. *BMJ open* 2014; 4(12): e006451.
- 20) Gangopadhyay S, Dev S. Design and evaluation of ergonomic interventions for the prevention of musculoskeletal disorders in India. *Annals of Occupational and Environmental Medicine* 2014; 26(1): 18.
- 21) Devanand G, John BD, Rajendra GK, et al. Use of complementary and alternative medicine for work related musculoskeletal disorders associated with job contentment in dental professionals: Indian outlook. *Ethiopian Journal of Health Sciences* 2014; 24(2): 117-124.
- 22) Kurşun Ş, Evirgen S, Akbulut N, et al. Work characteristics and musculoskeletal disorders among postgraduate dental students: A pilot study. *Journal of Musculoskeletal Pain* 2014; 22(1): 62-67.
- 23) Botha P, Chikite U, Esterhuizen T, et al. Self-reported musculoskeletal pain among dentists in South Africa: A 12-month prevalence study. *South African Dental Journal* 2014; 69(5): 208-213.
- 24) Gopinadh A, Devi KNN, Chiramana S, et al. Ergonomics and musculoskeletal disorder: as an occupational hazard in dentistry. *The Journal of Contemporary Dental Practice* 2013; 14(2): 299.
- 25) Bârlean L, Dănilă I, Săveanu I, Balçoş C. Occupational health problems among dentists in Moldavian Region of Romania. *Revista medico-chirurgicala a Societății de Medici și Naturaliști din Iași* 2013; 117(3): 784-788.
- 26) Hayes MJ, Smith DR, Taylor JA. Musculoskeletal disorders and symptom severity among Australian dental hygienists. *BMC Research Notes* 2013; 6(1): 250.
- 27) Rafeemanesh E, Jafari Z, Kashani FO, et al. A study on job postures and musculoskeletal illnesses in dentists. *International Journal of Occupational Medicine and Environmental Health* 2013; 26(4): 615-620.
- 28) Al Ali K, Hashim R. Occupational health problems of dentists in the United Arab Emirates. *International Dental Journal* 2012; 62(1): 52-56.
- 29) Biswas R, Sachdev V, Jindal V, et al. Musculoskeletal disorders and ergonomic risk factors in dental practice. *Indian Journal of Dental Practice* 2012; 4: 70-74.
- 30) Chamani G, Zarei MR, Momenzadeh A, et al. Prevalence of musculoskeletal disorders among dentists in Kerman, Iran. *Journal of Musculoskeletal Pain* 2012; 20(3): 202-207.
- 31) Osazuwa Peters N, Azodo CC, Obuekwe ON. Occupational health issues of oral health care workers in Edo State, Nigeria. *International Dental Journal* 2012; 62(3): 117-121.
- 32) Kierklo A, Kobus A, Jaworska M, et al. Work-related musculoskeletal disorders among dentists-a questionnaire survey. *Annals of Agricultural and Environmental Medicine* 2011; 18(1): 79-84.
- 33) Alexandre PCB, da Silva ICM, de Souza LMG, et al. Musculoskeletal disorders among Brazilian dentists. *Archives of environmental & occupational health* 2011; 66(4): 231-235.
- 34) Barghout NH, Al-Habashneh R, Al-Omiri MK. Risk factors and prevalence of musculoskeletal disorders among Jordanian dentists. *Jordan Medical Journal* 2011; 45(2): 195-204.
- 35) Harutunian K, Gargallo Albiol J, Barbosa de Figueiredo RP, et al. 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. *Medicina Oral, Patología Oral y Cirugía Bucal* 2011; 16(3): 425-429.
- 36) Goodrich JM, Wang Y, Gillespie B, et al. Glutathione enzyme and selenoprotein polymorphisms associate with mercury biomarker levels in Michigan dental professionals. *Toxicology and Applied Pharmacology* 2011; 257(2): 301-308.
- 37) Azizi MH. Occupational noise-induced hearing loss. *The International Journal of Occupational and Environmental Medicine* 2010; 1(3): 116-123.
- 38) Ayers K, Thomson W, Newton J, et al. Self-reported occupational health of general dental practitioners. *Occupational Medicine* 2009; 59(3): 142-148.
- 39) Puriene A, Aleksejuniene J, Petrauskiene J, et al. Self-reported occupational health issues among Lithuanian dentists. *Industrial Health* 2008; 46(4): 369-374.
- 40) Denton D, Newton J, Bower E. Occupational burnout and work engagement: a national survey of dentists in the United Kingdom. *British Dental Journal* 2008; 205(7): 382-383.
- 41) Ayers K, Thomson W, Newton J, et al. Job stressors of New Zealand dentists and their coping strategies. *Occupational Medicine* 2008; 58(4): 275-281.
- 42) Chadwick R, Alatsaris M, Ranka M. Eye care habits of dentists registered in the United Kingdom. *British Dental Journal* 2007; 203(4): E7.
- 43) Dong H, Loomer P, Barr A, et al. The effect of tool handle

- shape on hand muscle load and pinch force in a simulated dental scaling task. *Applied Ergonomics* 2007; 38(5): 525-531.
- 44) Gorter R, Storm M, Brake JT, et al. Outcome of career expectancies and early professional burnout among newly qualified dentists. *International Dental Journal* 2007; 57(4): 279-285.
  - 45) Gijbels F, Jacobs R, Princen K, et al. Potential occupational health problems for dentists in Flanders, Belgium. *Clinical Oral Investigations* 2006; 10(1): 8-16.
  - 46) Atesagaoglu A, Omurlu H, Ozcagli E, et al. Mercury exposure in dental practice. *Operative Dentistry* 2006; 31(6): 666-669.
  - 47) Farrier S, Farrier J, Gilmour A. Eye safety in operative dentistry-A study in general dental practice. *British Dental Journal* 2006; 200(4): 218-223.
  - 48) Droeze EH, Jonsson H. Evaluation of ergonomic interventions to reduce musculoskeletal disorders of dentists in the Netherlands. *Work* 2005; 25(3): 211-220.
  - 49) Canto-Pereira LH, Lago M, Costa MF, et al. Visual impairment on dentists related to occupational mercury exposure. *Environmental Toxicology and Pharmacology* 2005; 19(3): 517-522.
  - 50) Alexopoulos EC, Stathi IC, Charizani F. Prevalence of musculoskeletal disorders in dentists. *BMC Musculoskeletal Disorders* 2004; 5(1): 16.
  - 51) Ritchie K, Burke F, Gilmour W, et al. Mercury vapour levels in dental practices and body mercury levels of dentists and controls. *British Dental Journal* 2004; 197(10): 625-632.
  - 52) Werner R, Hamann C, Franzblau A, et al. Prevalence of carpal tunnel syndrome and upper extremity tendinitis among dental hygienists. *Journal of Dental Hygiene: JDH* 2002; 76(2): 126-132.
  - 53) Al Wassan K, Almas K, Al Shethri S, et al. Back & neck problems among dentists and dental auxiliaries. *Journal of Contemporary Dental Practice* 2001; 2(3): 17-30.
  - 54) Stonehouse C, Newman A. Mercury vapour release from a dental aspirator. *British Dental Journal* 2001; 190(10): 558-565.
  - 55) Chohanadisai S, Kukiattrakoon B, Yapong B, et al. Occupational health problems of dentists in southern Thailand. *International Dental Journal* 2000; 50(1): 36-40.
  - 56) Alzahem AM, Van der Molen HT, Alaujan AH, et al. Stress management in dental students: a systematic review. *Advances in Medical Education and Practice* 2014; 5: 167-176.
  - 57) Wicker S, Rabenau HF. Occupational exposures to bloodborne viruses among German dental professionals and students in a clinical setting. *International Archives of Occupational and Environmental Health* 2010; 83(1): 77-83.
  - 58) Al-Sowygh ZH. Academic distress, perceived stress and coping strategies among dental students in Saudi Arabia. *The Saudi Dental Journal* 2013; 25(3): 97-105.
  - 59) Werner RA, Hamann C, Franzblau PA. Prevalence of Carpal Tunnel Syndrome and upper extremity tendinitis among dental hygienists. *Journal of Dental Hygiene* 2002; 76: 126-132.
  - 60) Cherniack M, Dussetschleger J, Bjor B. Musculoskeletal disease and disability in dentists. *Work* 2010; 35(4): 411-418.
  - 61) Lönnroth EC, Shahnava H. Users' demands regarding dental safety glasses. Combining a quantitative approach and grounded theory for the data analysis. *International Journal of Occupational Safety and Ergonomics* 2001; 7(1): 49-59.
  - 62) Leggat PA, Chohanadisai S, Kedjarune U, et al. Health of dentists in southern Thailand. *International Dental Journal* 2001; 51(5): 348-352.
  - 63) Sampaio Fernandes J, Carvalho A, Gallas M, et al. Noise levels in dental schools. *European Journal of Dental Education* 2006; 10(1): 32-37.
  - 64) Szymańska J. Work-related noise hazards in the dental surgery. *Annals of agricultural and environmental medicine* 2000; 7: 67-70.
  - 65) Chopra S, Pandey S. Occupational hazards among dental surgeons. *Medical Journal Armed Forces India* 2007; 63(1): 23-25.
  - 66) Diaz-Caballero AJ, Gómez-Palencia IP, 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): e906.
  - 67) Tezel H, Ertas O, Ozata F, et al. Occupational health: Blood mercury levels of dental students and dentists at a dental school. *British Dental Journal* 2001; 191(8): 449-452.
  - 68) Guzzi G, Pigatto PD, Ronchi A, et al. Exposure to mercury among Norwegian dentists and dental healthcare personnel. *Scandinavian Journal of Work, Environment & Health* 2010; 36: 430-431.
  - 69) Schedle A, Örtengren U, Eidler N, et al. Do adverse effects of dental materials exist? What are the consequences, and how can they be diagnosed and treated? *Clinical Oral Implants Research* 2007; 18(s3): 232-256.
  - 70) Younai FS, Murphy DC, Kotelchuck D. Occupational exposures to blood in a dental teaching environment: results of a ten-year surveillance study. *Journal of Dental Education* 2001; 65(5): 436-448.