

Work-related musculoskeletal disorders among dentists and their prevention through ergonomic interventions - A systematic review

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ABSTRACT

Introduction: Occupational/Work-related musculoskeletal disorders (WMSDs) vastly prevail among the dental professionals. This review aims to summarize the prevalence of WMSDs and ergonomic interventions for the prevention of WMSDs among dental professionals.

Methods: Thorough literature search was done using scientific databases. The terms musculoskeletal disorders (MSD) among dentists/dental professionals/ hygienists in dentistry, occupational or work-related MSDs, ergonomics, ergonomic interventions, and several combinations were used as keywords. Articles published in English language only were included. Abstracts, thesis work, and other languages were excluded.

Results: Our findings revealed several studies showing the prevalence of WMSD among dental professionals and ergonomic interventions to prevent MSDs among dental professionals.

Conclusion: Dental practice is highly challenging both in terms of physical and mental status and there is a need for continuing efforts to discover innovative preventive strategies, to reduce the prevalence of WMSDs. This article guides the dental professionals to incorporate the proper ergonomic methods in their early stages of day-to-day work, for long-term and healthy dental practice.

Key words: dental occupation, ergonomic interventions, musculoskeletal disorders, preventive measures.

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INTRODUCTION

The goal of dental professionals is to promote oral health and to provide dental care in a safe environment. While treating the patients, the dental professionals need to work in a complex human oral cavity with precise hand movements, use vibrating dental instruments, and work in small and cramped clinical setups, hence they compromise on their health and adopt awkward postures with tense muscles during work.¹ Therefore, the prevalence of musculoskeletal disorders (MSDs) is highest among dentists often



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leading to the deprived quality of work, decreased job satisfaction, work-related accidents, and early quitting of the occupation.² Additionally, the treatment expenditures of MSDs are relatively high often causing an economical burden.³

According to the World Health Organization (WHO), MSDs are defined as “A disorder of the muscles, tendons, peripheral nerves, or vascular system not directly resulting from an acute or instantaneous event (e.g., slips or falls). Work-related musculoskeletal disorders (WMSDs) occur/get worsen and become chronic illnesses due to the risk factors associated with the work environment.⁴ WMSDs are usually associated with single or multiple injuries often leading to pain or disturbances in sensory nerve distribution among various parts of the body, representing about 40% of all chronic diseases.⁵ It is important to prevent the prevalence of WMSDs among dental professionals for promoting good physical & mental health status, and for maintaining a balance between health and work.²

The word “ergonomics” is derived from the Greek terms, *ergon* (labor) and *nomia* (arrangement). “It is the conception to designing the workplace that is harmonious for the physical and mental well-being of the working person.⁶

Dental ergonomics, when practiced throughout the working life, can reduce the prevalence of MSDs among dental professionals. Generally, insufficient training in ergonomics during preclinical and clinical courses in dental schools, inappropriate designing of the workplace, facilities, and physical and mental stress while working lead to the adoption of unsuitable positions during work.¹ Occurrence of WMSDs is highest among dental professionals and literature regarding the association of risk factors and interventions differ.⁷ This review article primarily aims to provide concrete insight into the prevalence of WMSDs with emphasis on preventive and ergonomic interventions among dental professionals.

METHODS

A systematic review of the literature was performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.⁸ Since it is a systematic review of published literature, neither ethical committee approval nor informed consent was obtained and there was no contact with real study participants at any time.

Sources of information & Search strategy:

A meticulous literature search was done to identify the relevant studies and reference lists using electronic databases such as PubMed, Pubmed Central, Web of Science, Scopus, Science Direct. The eligibility criteria for inclusion and exclusion of studies were developed following the Population, Intervention, Control group, Outcome and Study design (PICOS) scheme (Table 1).⁹ Additional criteria like the language, publication status, and period specified by the authors were also considered. The study was included in the review only if it met all the predefined eligibility criteria. The present study selected the articles from the last ten years for the recent update in the field, since the recent articles include the previous literature along with new findings/insights in this particular area hence, we included only studies from 2011 to 2021. The last search was completed on the 14th of December 2021. The terms used as keywords were musculoskeletal disorders among dentists/dental professionals/ in dentistry, occupational or work-related MSDs, ergonomics, ergonomic interventions, and several combinations of these keywords.

The screening process for the selection of studies was conducted in two phases. First, the titles, and abstracts of all the studies retrieved from the selected electronic databases were independently reviewed by two authors. Abstracts full-filling the inclusion criteria were reserved for full-text assessment. In phase 2, the selected full-text articles in phase1 were assessed by the same two authors. In case of a disagreement between the two authors in the selection process, a third author was approached to reach a consensus. Full-text articles published in the English language were systematically reviewed. The studies were evaluated based on the content related to the prevalence, occurrence of MSDs among dental professionals and ergonomic interventions to prevent them. The primary factor to be evaluated was the prevalence of WMSDs among dental professionals. The second factor to be evaluated was the ergonomic interventions to prevent or reduce the WMSDs among dental professionals. The selected articles were carefully analyzed based on the criteria set by Cochrane Collaboration's tool.¹⁰ to evaluate the risk of bias. Such as randomization of selected sample size, blinding process in intervention studies, any deviations from intended interventions by evaluating the methodology, any bias arising from missing outcome data, and if the study is not clear

about the total sample size and number of participants included. The results of studies were also carefully analyzed using the tool criteria as shown in table 2. If the study fulfilled the tool objective then the risk is identified to be as “low”, if any doubt is raised than it is identified to be as “some concern.” The overall bias is calculated, if the study has at least one score of “some concern” than the overall bias for that particular study is considered as “some concern”.(Table 2). The literature findings of the included studies are described in Tables 3 and 4.

RESULTS

A total number of 382 titles were obtained during initial screening, and another 6 studies were identified by manual reference searching, therefore, a total of 388 studies were identified. Out of these studies, 304 titles were obtained from PubMed and PubMed Central, 48 from Science Direct, and 36 studies were obtained from Scopus. After removal of duplication 212 articles were screened for the study. Among these, 172 studies were excluded after the title and abstract screening as they did not fulfill the predefined eligibility criteria on initial screening. Out of 40 studies selected for full-text manuscripts, 17 studies did not meet the eligibility criteria hence, were excluded from the study. Finally, 23 articles were included for a detailed description out of which, 9 studies were regarding the prevalence of MSDs among dental professionals and the remaining 14 were the intervention studies. Careful analysis was done to prevent the inclusion of studies that were previously studied, attempts were done to include the recent literature (Figure 1).

All the included studies were scientific studies evaluating the prevalence of WMSDs among dental professionals and studies pertaining to ergonomic interventional modalities to prevent or reduce the WMSDs among the dental professionals. All the included studies were published in the English language between January 2011 and December 2021. Over the past few years, specific inclination towards this area of research has been seen with an increase in the number of

publications, and the most recent article was published in the year 2021.¹⁸ Since, recent studies related to both prevalence and interventions are scarce hence, this systematic review was done to include recent literature of both prevalence and ergonomic interventions related to MSDs among dental professionals.

The included studies pertaining to the prevalence of MSDs and ergonomic interventions among dental professionals were conducted across five different continents. Fifteen studies were conducted in Asia (India, Iran, Japan, Lebanon and Saudi Arabia), one study each from South America (Brazil) and Australia (Oceania), two studies from North America (San Francisco) and four studies from Europe (Italy and Germany). Dental professionals were selected as the study population in most of the studies whereas, undergraduate dental students were used as the study population in five of the intervention studies.

The sample size in the studies ranged from 10 to 646 subjects. The higher study population (n = 646) a cross-sectional study including dentists was done evaluating the prevalence of MSDs among dental professionals¹¹, and the study with 10 dentists was a recent intervention study.²⁶ For the prevalence of MSDs in dental professionals, among the 9 studies included, most of these studies were cross-sectional, analytical studies that conducted surveys. The survey instruments used in the studies were either open-ended or closed-ended structured questionnaires, standardized and validated questionnaires and self-developed questionnaires, Other methods of assessment were photographs or videotapes, posture assessment techniques (e.g., REBA) (Table 3). The findings are shown in Table 3.

The concepts of dental practice have been changed significantly, however; the problems still exist. Hence, several interventions have been introduced to overcome these problems. From our literature search, emphasis was put to include recent literature. About 14 intervention studies were included in this review that are related to several ergonomic interventions. The literature findings are listed in Table 4.

Table 1: The eligibility criteria for inclusion of studies using PICOS scheme.

	Inclusion criteria	Exclusion criteria
P (Population)	Dental professionals including dental students- undergraduate/ and postgraduate/ Interns or house surgeons.	Non-dental professionals such as receptionists, and auxiliary staff and other health care professionals (doctors, surgeons, physiotherapists, nurses, etc.)
I (Intervention)	Studies pertaining to the prevalence of MSD among dental professionals. Studies pertaining to ergonomic interventions among dental professionals.	Prevalence studies of MSDs in other professionals Studies considering ergonomic intervention methods not related to dental professionals.
C (Comparison)	For prevalence studies, control group was not applicable. Studies with a control group without intervention, and as well as subjects representing both the intervention and control group (own controls).	Studies with non-control groups for ergonomic intervention
O (Outcome)	Studies show the prevalence and incidence of work-related musculoskeletal disorders among dental professionals. Studies with intervention methods to relieve the work-related musculoskeletal disorders among dental professionals. It helps to understand the prevalence of MSDs among dental professionals and adopt the intervention methods to prevent them.	Studies with prevalence and incidence of work-related musculoskeletal disorders and ergonomic intervention among other health professionals viz., GPs, specialists, dental nurses, dental technicians, hygienists, receptionists, auxiliary staff
S (Study Type)	Surveys, Randomized controlled trials Crossover studies Cohort studies Pre-post-test studies Intervention/Experimental studies.	Opinion pieces Thesis Short communications Reviews
Additional criteria		
Language	English	Non -English
Publication status	Published and accessible articles from peer-reviewed journals.	Unpublished data, Abstracts, thesis work, short communications, letters to editors, conference papers
Period	Studies with a publication date from January 2011 to December 2021.	Before and after the stated period.

Table 2: Evaluation of risk of bias using Cochrane Collaboration's tool

Study	Bias arising from the randomisation process	Bias due to deviations from intended interventions	Bias due to missing outcome data	Bias in measurement of the outcome	Bias in selection of the reported result	Overall bias
Studies showing the prevalence of work-related musculoskeletal disorders (WMSDs) among dental professionals.						
Kumar VK et al ¹¹ 2013	Low	Low	Low	Low	Low	Low
Aljanakh M et al ² 2015	Low	Low	Some concern	Low	Low	Some concern

Prudhvi K and Murthy KR ¹² 2016	Low	Low	Some concern	Low	Low	Some concern
Jaoude SB et al ¹³ 2017	Low	Low	Low	Low	Low	Low
Ispier Garbin ¹⁴ AJ et al 2017	Low	Low	Low	Low	Low	Low
Meisha DE et al ¹⁵ 2019	Low	Low	Low	Low	Low	Low
Kumar M et al ¹⁶ 2020	Low	Low	Some concern	Low	Low	Some concern
Ohlendorf et al ¹⁷ 2020	Low	Low	Low	Low	Low	Low
Gandolfi et al ¹⁸ 2021	Low	Low	Low	Low	Low	Low
Studies of ergonomic interventions to prevent WMSDs among dental professionals.						
Koni et al ¹⁹ 2015	Some concern	Low	Some concern	Low	Low	Some concern
Dable et al ²⁰	Low	Low	Some concern	Low	Low	Some concern
Hallaj ²¹ 2016	Low	Low	Some concern	Low	Low	Some concern
Taraneh et al ²² 2016	Low	Some concern	Low	Low	Low	Some concern
Dabaghi-Tabriz F et al ²³ 2020	Low	Low	Some concern	Low	Low	Some concern
Remple D et al ²⁴ 2012	Low	Low	Low	Low	Low	Low
Suedbeck J R ²⁵ 2017	Low	Low	Low	Low	Low	Low
Katona K et al ²⁶ 2021	Low	Low	Low	Low	Low	Low
Aghilinejad M ²⁷ 2016	Low	Low	Some concern	Low	Low	Some concern
Hayes, M.J et al ²⁸ 2016	Low	Low	Low	Low	Low	Low
Lindgard ²⁹ 2016	Low	Low	Some concern	Low	Low	Some concern
Padhye NM et al ³⁰ 2017	Low	Some concern	Some concern	Low	Low	Some concern
Koneru S and Tanikonda R ³¹ 2015	Low	Low	Some concern	Low	Low	Some concern
Deolia SG et al ³² 2017	Low	Low	Low	Low	Low	Low

Table 3: Prevalence of MSDs among dental professionals.

Authors & year of study	Country	Sample size and study population	Study design and methods	Study findings
Kumar VK et al ¹¹ 2013	India	646 dentists	Cross-sectional survey using self-administered questionnaire	All dentists experienced the symptoms of at least one MSD with 100% period prevalence rate. The regions affected were neck (75.74%), wrist/hand problems (73.13%), lower back (72.01%), shoulder (69.4%), hip (29.85%), upper back (18.65%), ankle (12.31%), and elbow (7.46%). Number of regions affected were two (82.83%), three (51.86%), four, or more (15.11%). The associated symptoms were pain (99.06%), rigidity/stiffness (3.35%), tiredness (8.39%), discomfort (12.87%), clicking sounds (4.1%), and neurological (20.14%). Recurrent symptoms were present in 76.11%.

Aljanakh M et al ² 2015	Saudi Arabia	80 dentists	Cross-sectional study. Self-administered Questionnaire	The prevalence of MSDs was 77.9% involving lower back (73.5%), neck (66%) and shoulders (43.3%). Nearly 85% of participants were found to have MSDs affecting two or more sites.
Prudhvi K and Murthy KR ¹² 2016	India	120 dentists	Cross-sectional study; self-administered questionnaire.	Musculoskeletal pain among dentists was found with neck (56%), hand (39%), lower back (32%), and shoulder (18%). Lower back pain was found to be associated with gender, body mass index, height, and the experience. Whereas, hand problems were found to be related to the experience of the dentist.
Jaoude SB et al ¹³ 2017	Lebanon	314 dentists	Cross-sectional study using Questionnaire	Dentists complained of spinal pain (61.5%), cervical pain (31.6%), lumbar pain (22.3%) and dorsal pain (13.0%). Continuous pain (20.7%) and, occasional pain (65.8%). Carpal tunnel syndrome (7.6%). Tendinitis (22.3%) and arthritis of shoulder, elbow, wrist and hand (9.2%). headaches (30.6%).
Isper Garbin AJ et al ¹⁴ 2017.	Brazil	204 dentists	Cross-sectional study using Questionnaire	MSDs was found in 81.4% dentists, involving the neck (15.7%), shoulders (12.7%) and lower back (15.7%). Work related risk factors were found to be inappropriate bending or twisting of the back, working in the same position for long periods. Average pain intensity 3.8 % was found in symptomatic MSD among participants.
Meisha DE et al ¹⁵ 2019	Saudi Arabia	234 dentists	Cross-sectional study using a self-administered questionnaire survey.	Prevalence of WMSD was found to be 70% in dentists with pain in lower back (85%) and neck region (84.6%), Carpal tunnel syndrome (9%). High risk was found in females and who did not exercise. ergonomic practice informed was 24%.
Kumar M et al ¹⁶ 2020	India	151 dental professionals	Self-administered questionnaire	Prevalence of MSD in the last 12 months was 58.3% among dentists. Common site reported was neck (66.7%). Most commonly seen in Endodontists (88.02%). About 33.11% reported pain in multiple regions simultaneously.
Ohlendorf et al ¹⁷ 2020	Germany	406 dental assistants	Online Nordic Questionnaire	98.5% of dental assistants reported at least pain in one region during lifetime and 97.5% at least one complaint in the last 12 months and 86.9% in the last seven days. The regions affected were neck followed by shoulder, upper back and the lower back.
Gandolfi et al ¹⁸ 2021	Italy	323 dentists and Dental hygienists	Cross-sectional observational study; Self-administered Questionnaire.	About 84.6% dental professionals, females (87%), males 80% were affected by WMSDs involving neck (59.9%), shoulders (43.3%), lumbar region (52.1%), dorsal region (37.7%) and wrists (30.6%). Higher prevalence was found in operators working >5 h/day and >30 h/week and working for more than 2–5 years after graduation. Dentists who practiced yoga or stretching has lower WMSD (77%) when compared to other physical activities (84%).

Table 4: Ergonomic interventions and preventive measures to prevent MSDs among dental professionals.

Interventional parameter	Authors, year & Country	Type of the study & design	Sample size & study population	Study findings	Study Conclusion
Ergonomic training course	Koni A et al ¹⁹ 2015 Italy	Cross sectional study; self-administered questionnaire before and after 3 months training course.	55 dental students	MSDS was found in all participants: cervical neck (91%), lumbosacral region (64.2%), shoulders (43.6%), and wrist and hand (41.8%). Improvement was found in 49 % students after the training course	Ergonomic training course reduced the the prevalence of MSD among dental students.
Chair interventions	Dable et al ²⁰ 2014 India	The subjects were divided into three groups using different working seats with and without magnification. Working postures were evaluated using RULA tool	90 dental students	The results showed higher RULA scores for the conventional seats without magnification in comparison to saddle designed ergonomic chair along with magnification system	MSDs are often associated with poor working postures among dental students, hence it is recommended to incorporate ergonomic practice during dental course, to prevent MSDs.
Working postures	Hallaj ²¹ 2016 India	Work posture was evaluated using Rapid Upper Limb Assessment (RULA) and photographs, feedback questionnaire with the intervention group using ergonomic dental chair with arm support.	29 dentists	The combined bending and twisting of the back were decreased by 13.8% after using arm support chair. Finger problems were reduced by 20.7%; wrist problems decreased by 41.38%; pinch grip decreased by 17.2%; neck and shoulder problems while working decreased by 79.3%.	Work posture was improved among dentists using ergonomic dental chair with arm support.
	Taraneh et al ²² 2016 Iran	Working postures were evaluated using RULA tool and a questionnaire regarding knowledge about ergonomic principles in dentistry.	103 fourth and fifth year undergraduate dental students	About 66% of participants were at intermediate and high-risk levels for MSDs. no significant correlation was found between knowledge and RULA scorings.	Most of the students need to correct working postures. Taught and training of ergonomic principles along with periodic evaluations is needed to reduce the prevalence of MSD among dentists.

	Dabaghi-Tabriz F et al ²³ 2020 Iran	Posture was evaluated using REBA before and after a course on ergonomic principles.	117 senior dental students	Right-handed females showed significant change after the ergonomic course compared to other groups.	Ergonomic course can significantly decrease MSDs in right-handed female dentists' practitioners.
Instruments designs/weight	Remple D et al ²⁴ 2012 United States of America	Randomized participants received light instruments with wider diameter or set of heavy instruments with narrow diameter for oral prophylaxis. Pain levels were evaluated in right hand, wrist, elbow, forearm and shoulder weekly.	110 dental hygienists and dentists	Pain scores were relatively less in participants using lighter instruments with wide diameter.	The study results show that dental instrument design influences upper-extremity pain in dental practitioners. Use of light instruments helps to prevent the hand and shoulder pain among dental professionals.
	Suedbeck J R ²⁵ 2017 United States of America	Instruments with 4 different handle designs were used for scaling on artificial tooth models.	27 dental hygienists	The heavier handle instrument caused more muscle activity compared to instruments with lighter handles.	Weight and handle designs of instruments influences muscle activity of forearm among dental professionals.
Effect of line of vision	Katona K et al ²⁶ 2021 Japan	Effect of direct and mirror view methods of line of vision for tooth preparation on maxillary molar tooth in mannequin head on muscle activity, body tilt (angle), and sitting balance were evaluated using Electromyographic (EMG) measurements	10 male dentists	Direct view had greater values influencing on body tilt (angle), muscular activity, and posture except for the spinal column erector muscular activity compared to the mirror view method.	Direct view method for line of vision for tooth preparation, effect the lower back, shoulders, and neck of the dentist. Hence, correct use of line of vision prevents MSDs among dentists.
Magnification	Aghilinejad M ²⁷ 2016 Iran	An ergonomic intervention program using optical magnification lens was carried out among dentists to evaluate the occurrence of MSDs before and after intervention programme using Nordic Questionnaire and a census method.	75 dentists	The occurrence of MSDs involving neck, back, shoulder, arm and whole body significantly reduced after the ergonomic intervention among dentists.	Optical magnification loupes, provide a suitable working to dentists, hence reduce the occurrence of MSDs in long run.

flip-up Galilean loupes	Hayes, M.J et al ²⁸ 2016 Australia.	Use of loupes on neck pain and disability was evaluated using Pre and post-test with a scale using previously validated measures.	29 dental hygienists	Neck pain was found to be higher with forward head posture and cervical kinesthetic sense.	wearing loupes appears to have both positive and negative outcomes the use of magnification loupes created no significant changes in neck pain and disability in dental hygienists over time. The use of magnification loupes had no significant effect on improving symptoms of neck pain and disability in dental hygienists, but a slightly positive impact can be assumed.
Prismatic glasses	Lindegard ²⁹ 2016 Sweden	Baseline questionnaire regarding neck pain, followed by neck examination along with work ability Index and intervention group using prismatic spectacles. After 12-month, follow up clinical examination along with questionnaire	564 dental personnel	Reduction in neck pain and improvement in self-rated work ability was found in the intervention group.	Use of prismatic glasses prevents the incidence of neck pain among dental personnel.
Physical exercise / stretching and or Yoga practice.	Padhye NM et al ³⁰ 2017 India	Pinching strength (PS) of the muscles related to fingers, before and after the scaling and root planning procedures, among dental professionals who practiced chair-side hand and finger stretches (test group) was compared with those who did not practice the same (control group).	40 dental professionals.	A decline in PS was found to be more in the test group compared to the control group.	WMSD related to fingers and hands among dental professionals can be reduced by performance of simple chair-side stretches.

	Koneru S and Tanikonda R ³¹ 2015 India	MSDS among the dentists who practiced yoga, was compared to those performing physical activity, and no physical activity.	220 dentists	Prevalence of MSDS among dentists practicing regular yoga was 10.5%, other physical activities was 21.7%, and dentists with no physical activity was 45.6%.	Inducing in any physical activity especially regular practice of yoga reduces the occurrence of work-related musculoskeletal disorders among dentists.
	Deolia, SG et al ³² 2017 India	The therapeutic effect of yoga on psychological and physical ailments among dental interns aged between 21 to 24 years was evaluated using a pretest questionnaire, followed by yoga training for a month after which they were subjected to a posttest questionnaire assessing the levels of stress and relief from musculoskeletal ailments.	120 dental interns	Yoga training has significantly improved the quality of life among dental interns and MSDs were reduced.	Practicing yoga on daily basis changes the dentist's lifestyle helps them to maintain balance between the profession and health.
Number of articles identified by database search. n= 382 References n= 6.					
Total Number of articles identified for study n= 388					
IDENTIFICATION	PUBMED& PUB MED CENTRAL n= 304		SCIENCE DIRECT n= 48		SCOPUS n=36
	Manuscripts obtained after removal of duplication (n=212)				
SCREENING	Manuscript screened from Database n=212		Records excluded after title- abstract screening (n = 172)		
ELIGIBILITY	Full-text manuscripts eligible to include in the study n= 40		Full-text manuscripts excluded based on eligibility criteria n= 17 i.e, thesis n= 8 Manuscripts in non-English languages n= 9		
	INCLUDED Articles included for final analysis n= 23				

Figure 1: Flowchart of systematic review process carried out according to PRISMA guidelines.

DISCUSSION

The highest prevalence of musculoskeletal disorders (MSDs) and pain are seen among dental professionals. Primary types of WMSDs that affect dentists are back problems (lower back & upper back), hand & wrist

problems including shoulder and neck as described in Table 3.

Some of the risk conditions associated with the occurrence of different MSDs are as follows: Multiple factors trigger the occurrence of Lower Back Pain

(LBP), nevertheless, the combination of flexural and lumbar rotary motions is the high-risk factor. The upper back pain is uncommon unlike that of the LBP. Scapular and postural muscular pain often leads to pain in the middle back region. Pain in the neck area is attributed to the lack of adequate secretion of synovial fluid that occurs due to motionless, continuous working in the same position without rest, which in turn induces increased pressure on the intervertebral disk and triggers muscular hypoxia. Severe or mild pain in the trapezius muscle region and neck of the dominant hand occurs due to the high electrical activity of this muscle during posture maintenance. This is the most common symptom with the highest occurrence in women.^{33,34} Hand and wrist problems occur as a result of constant and repetitive flexural and extendable movements that often cause pain especially with the squeezing hand position.

Dentists adopt the awkward positions that result in excessive stress on the spine primarily for obtaining optimal view during dental procedures, to provide a comfortable position to the patient, to coordinate between the assistant and to reach the operating instruments and equipment. Continual twist and bend motions or constant pressure on various joints of our body without rest times further inflicts the stress on these joints eventually leading to WMSDs.²¹ The amount of risk essentially depends on the frequency, intensity, and duration of the exposure to the conditions involving repetitive, forceful, vigorous, or prolonged efforts of the hands, wrists, fingers, elbows, shoulders, neck, and other body parts and also affected by working style.³³

Changing concepts in dentistry such as four-handed dentistry was first integrated into the dental profession during 1960s. Ergonomic interventions were introduced in order to prevent or reduce the MSDs among dental professionals. Since MSDs are multifactorial, hence the dentist must be well versed with ergonomic techniques and should train themselves and get acquainted with ergonomic dental practice to prevent the occurrence of MSDs. The operatory site of the dental treatment should be well organized that allows ergonomic postures for the dentist and auxiliary staff while working. The work settings should consider the position and height of the operator's and patient's chair, arm and back support of the operator's stool/ chair, location of instrument counter and ease of access to the equipment and materials during the procedure. In addition, enough illumination,

appropriate room aeration and temperature should be considered for providing a comfortable and ergonomic workplace.²

The patient should be in the supine position in the chair, the operator should adjust the patient chair so the operator's thighs can freely turn below the patient's chair and allows for maintaining the neutral posture for utmost intraoral access, and maxillary plane should be extended 7° beyond the vertical. For access to the maxillary posterior teeth, the plane of maxilla should be 25° away from the vertical plane whereas, for access to the mandibular anterior region, the patient's chin is positioned downwards to allow the maxillary plane to be placed 8° in front of the vertical plane.⁶ Katona K et al²⁶, stated that direct view had greater values influencing body tilt (angle), muscular activity, and posture except for the spinal column erector muscular activity compared to the mirror view, Hence, correct use of line of vision prevents MSDs among dentists.

Dental professionals need to check their posture while working and maintain an erect posture i.e., normal curvature of the spine. Occurrence of MSDs was significantly less among the dentists who maintained a neutral, well-balanced posture and alternated between different work positions during dental procedures.³⁵ Taraneh et al²² evaluated the working postures and recommended that most of the students need to correct working postures. Taught and training of ergonomic principles along with periodic evaluations is needed to reduce the prevalence of MSD among dentists.

Early designs of dental chairs/stools were simple (often flat, round seat pans) with minimal adjustability and often designed for a person with average stature. It is recommended to use an adjusting/ modifiable operating chair/ stool with arm and back support during clinical procedures and should be adjusted according to the horizontal patient position and proper light. Dental operator chairs are now available in different models and can be adjusted according to the requirement of the operator's height. The operator must choose the proper one according to their comfort.³⁶ Saddle-type chairs provide better ergonomic seating for the operators rather than the chairs with a flat seat pan. Saddle-style stools and tilting-seat designs of operator's chair aid for obtaining 100° to 140° hip angle that is essential for retaining the less back curve, a smaller amount of pressure on the disc, reduce the occurrence of LBP and allows for operator's closer position to the patient while operating hence, allows for neutral postures.³⁶

Hallaj et al.²¹ stated that the use of an ergonomic dental chair with arm support had significantly reduced MSDs among dental professionals, improved the working postures, and led to a more positive impact among dentists. The RULA (Rapid Upper Limb Assessment) analysis showed positive outcomes and the body posture was almost in the correct position. Back problems decreased by 13.8%, fingers or arms (20.7%), wrist (41.38%), and the pressure on the neck and shoulder while operating was decreased by 79.3%.

Instruments design and weight during operative procedures also affect the different muscle groups. Dental practitioners must ponder to use automatic instruments rather than hand instruments whenever possible that reduces muscular force and digital nerve compression. According to Suedbeck J R, weight and handle designs of instruments influences muscle activity of the forearm among dental professionals. The instruments with heavier handles caused more muscle activity compared to instruments with lighter handles.²⁵ Remple D et al²⁴ showed that the use of the lightweight dental instrument with a wide diameter significantly reduces the symptoms of shoulder pain in dentists and dental hygienists. The modern instruments are designed to reduce physical and mental stress to the dentist; hence the use of these instruments plays a significant role in preventing MSDs.

Philosophies of visualization along with ergonomics have enhanced over the past few years. Magnification mainly assists in visual enhancement and ergonomics during dental procedures, especially for procedures of long duration in narrow operating spaces. The literature recommends the use of magnification tools such as loupes and operating microscopes that are significantly designed for improving ergonomics and magnification. Aghilinejad M²⁷ showed that, the occurrence of MSDs involving neck, back, shoulder, arm and whole-body significantly reduced after the ergonomic intervention with optical magnification loupes among dentists. Hayes, M.J et al²⁸ suggested that wearing flip-up Galilean loupes appears to have both positive and negative outcomes and created no significant changes in neck pain and disability in dental hygienists over time, but a slightly positive impact can be assumed. On the other hand, Lindegard²⁹ showed that prismatic glasses made significant positive changes in the working posture of dental professionals and reduced the incidence of pain in head and neck regions. Dable et al²⁰ evaluated 3 different dental chairs without and with

magnification loupes and their effects on the working posture of dental students. The use of saddle stool with magnification loupes was more comfortable for dental students, the working posture was greatly improved, and fewer or no MSDs were reported compared to the use of the conventional chairs without magnification loupes. Digital operating microscope offers better ergonomics and a higher level of magnification with wider range (3x-30x). Allows a parallel line of sight therefore, eye muscles are more relaxed and causes less eye strain. Allows for the steeper back curve and maintains perfectly neutral body posture.³⁷

Early intervention and prevention of MSDs are important as early symptoms usually respond to conservative treatment approaches with less cost and inconvenience with a good prognosis. Preventive measures includes basic stretching exercises after working on each patient and at the end of the working day while retaining the neutral posture.³⁸ Padhye NM et al³⁰ suggested that WMSD related to fingers and hands among dental professionals can be reduced by the performance of simple chair-side stretches.

Poor physical health may increase the risk of musculoskeletal injury. Fitness is a general term used to describe the ability to perform physical activities that requires the individuals ought to possess adequate cardiopulmonary function, stamina and musculoskeleton potency providing adequate flexible body movements. According to Koneru S and Tanikonda R,³¹ the prevalence of MSDs among dentists practicing regular yoga was 10.5%, other physical activities was 21.7%, and dentists with no physical activity/ exercise was 45.6%. Therefore, inducing in any physical activity especially regular practice of yoga reduces the occurrence of work-related musculoskeletal disorders among dentists which is also supported by Deolia SG et al.³²

Along with workstation modification, knowledge and training about ergonomics (training sessions) change the behavioral pattern of the dental professionals and improve the health by reducing the prevalence of MSDs. Koni A et al¹⁹ found that dentists who underwent the training programs had lower incidence rates of MSDs consequently, the ergonomic intervention program had a positive effect by significantly reducing the prevalence of MSDs in dentists. It is important to incorporate ergonomic principles in the curriculum in dental schools at the undergraduate level, as it plays an important role in training the dental students at

the early stages to adopt the ergonomic posture thus helping them for a lifetime healthy dental practice. Comprehensive theoretical and practical training regarding ergonomic principles is worth being introduced in dental schools before the clinical training to prevent the occurrence of WMSDs.³⁹ Taraneh et al²² suggested the taught and training of ergonomic principles along with periodic evaluations reduces the prevalence of MSD among dentists.

Limitations of the study: Most of the included studies enrolled the study subjects, with a relatively small sample size. Since the participants in some studies were aware of being observed, there is a possibility that they might have adopted a better posture than they normally have while working. The change in behavior of the participants, while being observed, is known as the Hawthorne effect.⁴⁰ Hence, the results obtained in such studies may have been underestimated. Most of the included studies were rated as some concerns in the blinding parameter, as both the study participants and the outcome evaluators were aware of the purpose of the research. Thus, the conclusions of the systematic review should be inferred with utmost caution. Future longitudinal randomized controlled studies should

be conducted based on a clinical dental setting for prevalence of WMSDs among dental professionals. Nevertheless, a practice-based study yields more satisfactory results of research outcome rather than a questionnaire. The study population should include large samples with different dental professionals with different years of clinical experience, and different specialties allowing for subgroup analysis for evaluating both prevalence and intervention of MSDs.

CONCLUSION

Dental practice is highly challenging both in terms of physical and mental status among the dental professionals, there is a need for continuing efforts to discover innovative preventive strategies, to reduce the prevalence of WMSDs to maintain a harmony between health and the work. The present article will guide the dental professionals to incorporate the proper ergonomic methods in their early stages of learning and also to modify their clinical setups, use the equipment that are more ergonomic with less stress and incorporate the ergonomic principles, practices and adopt the ergonomic interventions in their day-to-day work, for long-term and healthy dental practice.

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