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Abstract

Background: Musculoskeletal disorders (MSDs) usually result from a prolonged static position and repetitive movements. A comfortable environment, appropriate working position, and multiple short breaks could alleviate MSDs. While the occasional back or neck ache is not a cause for alarm, regularly occurring pain or discomfort, if ignored, may further develop into an injury or career-ending disability.

Methods: A total of 370 dentists were selected from two dental hospitals and multiple dental clinics in Lahore, Pakistan. Current MSDs were recorded with the Standardized Nordic Questionnaire (SNQ). Information sheets containing dental ergonomics and back and tendon-gliding exercises were distributed among the participants. The SNQ questionnaire was repeated after a 3-month interval.

Results: MSDs were found to be present in 59.5% of the clinicians surveyed. Males dentists were significantly more prone to MSDs than female ones ($p < 0.001$), and senior dentists had significantly fewer MSDs than younger dentists. The intervention of ergonomic guidelines and exercises led to a reduction in MSDs among dental clinicians, with neck pain being significantly reduced ($p = 0.003$).

Conclusions: MSDs affect the clinical practice of dental surgeons. Thus, incorporating more detailed ergonomics at the undergraduate level, along with the wider dissemination of correct dental postures, techniques, stretching, and rest to dentists, should be emphasized.

Keywords: dentistry, ergonomics, exercise, microbreaks, musculoskeletal disorders

INTRODUCTION

Musculoskeletal disorders (MSDs) are injuries or pain in the human musculoskeletal system, including the joints, ligaments, muscles, nerves, tendons, and other structures supporting the limbs, neck, and back.¹ MSDs can arise from sudden exertion, repetitive motions, or repeated exposure to force, vibration, or an awkward posture.² Injuries and pain in the musculoskeletal system caused by acute traumatic events, such as a fall or car accident, are not considered MSDs.³ Dentistry is a highly specific and skillful vocation that requires high precision, good concentration, and the handling of small tools and vibrating hand instruments over long periods of time. A dentist needs excellent vision, hearing sense, psychomotor skills, perception skills, and proprioceptive

skills.⁴ In addition, dentistry involves long working hours and static positions over prolonged periods of time; a powerful grip and controlled strokes are also imperative.⁵ These laborious processes may cause adverse physical conditions, such as MSDs. MSDs in dentists include pain and discomfort during routine dental treatment activities that could affect the quality of life of the clinician. It also creates stress such that many dentists between 40 and 50 years of age are unable to perform their routine clinical practice.⁶

MSDs may present different symptoms in different areas. The mechanisms behind the development of MSDs typically involve prolonged static postures, which, in turn, may cause imbalance and muscle necrosis, leading to spinal disc herniation, degeneration, and, eventually, hypomobile joints.⁷ Degenerative changes also progress with age, which is a potential risk factor for lower back pain. Lumbar rotation with flexion and a kyphotic posture can cause lumbar disc slip, which can lead to weakness of the spine, hips, pelvis, and abdominal muscles. Upper back pain is not as common as lower back pain, but pain may sometimes be reported

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in the mid and upper trunk region.⁸ As the thoracic spine is very strong and encloses vital organs, the risk of pain in this region is fairly low. Neck pain may be caused by the constant bending and twisting of the head and strain on the neck muscles.⁹ Holding small instruments involves the pinch grip position, causing flexion of both wrist and fingers. Holding handpieces for long durations and in awkward positions, along with their vibration, could cause pain in the hands and wrist.⁸ Working with small instruments without a finger rest or fulcrum induces constant stress on the hands and strain on the digital nerves, both of which lead to MSD. Vibratory instruments could lead to severe conditions, such as trigger finger, tendinitis/tenosynovitis, carpal tunnel syndrome, deQuervain's disease, and Guyon's disease. The initial signs of MSDs include loss of normal sensation, decreased range of motion, loss of muscle coordination, decreased grip strength, and difficulty in normal movement.¹⁰ Other symptoms may include numbness of the fingers and hands, a tingling and burning pain in the arms, fatigue in the shoulders and neck muscles, cramping of the hands, hypersensitivity in the hands and fingers, and clumsiness and dropping of objects.¹⁰

MSDs can be controlled by working in a comfortable environment. Appropriate working positions and intervals between consultations can play a key role in preventing MSDs.¹¹ Ergonomics, also known as human factors, refers to the engineering and design of products, systems, and processes to match the physical ability of a worker for his or her specific job.¹² Ergonomics subscribes to the concept of working smarter, not harder, with tools and equipment well suited to the workplace and its workers, thereby resulting in improved productivity and greater worker satisfaction. It also decreases workplace injuries, which leads to improved job processes and elimination of unnecessary tasks and effort. Furthermore, it increases a worker's knowledge of their job and minimizes physical fatigue.¹³ In dentistry, ergonomics can be applied to three aspects, including instruments, dental units, and the dentist him/herself. Instrument ergonomics includes light weight or hollow instruments that are sharp or powerful with built-in lights where applicable. Color coding of instruments for better identification with round and textured grips is also useful.¹³ For dental unit ergonomics, the operatory should have sufficient space and be well lit, the dental unit should have a good light source, and the instruments must be within comfortable reach. Portable trolleys can be used for instruments that are not used routinely.¹⁴ For dentist ergonomics, the seating should always be perpendicular, with the knees beneath the patient. The dentist should have a tight pinch grip on the instruments with the wrist held in a neutral position. Eye loupes and telescopic loupes can be used to magnify the view.¹⁴ These solutions are ideal ergonomic recommendations for dental clinics, but dentists often continue to adopt unsuitable positions, which may harm

their health. Besides ergonomics, specific exercises can be employed to reduce MSDs and help prevent lower back and neck issues among dental clinicians. Multiple studies show that frequent exercise decreases the symptoms of painful and anxiety caused by MSDs.¹⁵ A lack of rest and torpid lifestyle could also lead to increased risk of developing medical conditions and cardiovascular problems.

Previous research on MSDs revealed consistent trends for low- and middle-income countries; that is, low-income countries have a higher prevalence of MSDs compared with high-income countries. According to an earlier estimate, MSD is the second leading cause of absenteeism from work.¹⁶ In Saudi Arabia, Abdul-Jabbar reported that 82% of the surveyed dentists have musculoskeletal disorders.¹⁷ In India, Dayakar reported an MSD frequency of nearly 78%.¹⁸ Other studies worldwide also report the relatively high prevalence of MSDs among dentists, and reports of MSDs as the leading cause (28.4%) of early retirement among dentists have been published.¹⁹ Several studies in Pakistan sought to determine the frequency of MSDs among dental clinicians. However, these studies used multiple questionnaires that do not cover the scope of MSDs completely and usually lack solutions to the problem. The present study aimed to determine the frequency of work-related MSDs among dentists in Lahore and gauge the multiple risk factors of the prevalence of MSDs following the intervention of ergonomics, exercises, and microbreaking. The intervention was targeted to provide awareness to dentists about the benefits of creating ergonomic workplaces to prevent the onset of musculoskeletal disorders. Ergonomics awareness to promote the health and wellbeing of the dentist is necessary to prevent adverse effects on a dentist's career.¹⁵

METHODS

This research was conducted in two dental hospitals and 12 dental clinics in Lahore and. Among the two dental hospitals of Lahore, one was a government hospital (i.e., Punjab Dental Hospital), and one was a private hospital, i.e., Fatima Memorial Hospital. A cross-sectional survey was used for data collection, and 370 dentists were provided the questionnaire. These questionnaires were completed over a 6-month period (March 2017–August 2017). The sample size was calculated using Cochran's formula for a small population of dentists in Pakistan. The parameters for sample size selection were a confidence level of 95%, standard deviation of 0.5 (50% response rate), and margin of error of 5%. Under these conditions, an estimated sample size of 346 was obtained. This number was increased to compensate for losses. The inclusion criterion was all dentists working in a hospital or dental clinic. Clinicians and teaching faculty were included. Fresh graduates and house officers were

also excluded because they typically do not have much clinical experience. Dentists who had recently undergone surgery or had thyroid dysfunction, as well as those who refused to provide informed consent, were also excluded.

This work is a questionnaire-based study. The questionnaire used was the Standardized Nordic Questionnaire (SNQ), which records MSD symptoms very well.²⁰ SNQ is a validated and reliable questionnaire that is used as a diagnostic instrument for checking the working environment against back, neck, shoulder, and general muscular complaints (e.g., pain and discomfort) in epidemiological studies.²¹ The original language of development of the SNQ is English; because the medium of study for dentistry in Pakistan is English, no translation was required for the questionnaire prior to its dissemination to the dentists. Demographic variables, including age, gender, years of practice, duration of working hours per day, and reasons for MSD, were obtained. Age was divided into three categories of young dentists (age, <30 years), senior dentists (age, 31–45 years), and older dentists (age, >45 years). Qualifications, namely, bachelor's degree and postgraduate degree, were also noted. After the initial questionnaire had been disseminated, all participants were handed three separate instruction sheets. The first sheet included ideal ergonomics for clinical practice, including postural changes, along with patient and instrument positions, according to the guidelines of the FDI and ISO.²² The second sheet included tendon-gliding exercises.²³ The last sheet included neck and back exercise techniques, along with the benefits of microbreaks.^{24,25} After 3 months, a follow-up questionnaire was distributed to the previous respondents to determine whether they had applied dental ergonomics, microbreaks, and exercises to their everyday practice as recommended in the instruction sheets distributed earlier. The SNQ questionnaire was also distributed to all previous participants to evaluate difference in the information created. Only 141 out of the initial 370 responded to the second questionnaire.

Ethical permission was obtained from the University of Punjab, Ethics Committee (D/No. 2704-P.U.). The study purpose was described to each participant, and verbal consent was obtained from all participants, who were informed of their voluntary participation and data protection. All data collected were entered into SPSS version 20 for further analysis. The chi-squared test was used for to assess relationships, and a 95% significance level $p < 0.05$ was selected.

RESULTS

The target population for the study was practicing dental surgeons in Pakistan. Among the 370 participants who participated in this study, 241 (65.1%) were males and

129 (34.9%) were females. Most of the participants were young dentists aged <30 years (226, 61.0%), and the mean age was 28 years (95%CI 22.4–38.7). While some of the participants had postgraduate training (126, 34.1%), most had a bachelor's education (244, 65.9%). Out of the 370 participants, 280 worked less than 6 hours per day, whereas 90 worked between 6 and 12 hours per day. Among these 90 respondents, 79 were males and 11 were females. Table 1 shows the detailed demographics of the study population. Among 370 dentists, 220 (59.5%) reported MSD issues. This group comprised 158 males and 62 females. Upon further inquiry, 97 (26.2%) attributed their MSD to a lack of rest and 77 (20.8%) attributed it to maintaining a static position for long periods of time. Only 45 (12.2%) participants attributed their MSD to a lack of rest and static position. According to the SNQ, 44.1% of the participants reported pain in the neck and 38.4% reported pain in the lower back. Only 7.8% experienced hand and wrist pain. Table 2 presents the frequencies for MSDs in different parts of the body of the participants.

TABLE 1. Characteristics and demographics of the study population (N = 370)

Variables	Frequency	Percentage (%)
Gender		
Male	241	65.1
Female	129	34.9
Age		
<30	226	61.0
31–44	95	25.6
>45	49	13.2
Qualification		
Bachelor	244	65.9
Post-Graduation	126	34.1
Duration of work per day		
0–6 hours	280	75.7
7–12 hours	90	24.3
Presence of MSD		
Yes	220	59.5
No	150	40.5
Use of medicines for MSD		
Yes	34	9.2
No	336	90.8
Reasons for MSD		
Lack of rest		
Yes	97	26.2
No	273	73.8
More than 30 min positioning		
Yes	77	20.8
No	293	79.2
Both		
Yes	45	12.2
No	325	87.8

The chi-squared test revealed that gender and age are significantly related to MSD. Working long hours every day and qualifications were not significantly related to MSD. Table 3 provides the p for each variable tested. In the second phase of this research, which was conducted 3 months later, the participants were asked whether they had successfully applied ergonomics to their clinic. Out of 370 initial participants, only 141 (38.1%) reported applying ergonomics at their workplaces. All 141 participants who implemented ergonomics and exercises reported improvements in their MSDs. According to the responses to the SNQ questionnaires provided for the second phase of this study, neck pain frequency decreased from 44.1% to 21% and lower back pain frequency decreased from 38.4% to 26%. An overall reduction in pain in all other locomotor organs was also noted. Comparison SNQs scored shows a significant t -test difference with $p < 0.05$ for neck pain only (Table 4).

TABLE 2. Frequency distributions of MSDs among dentists in Lahore (N = 370)

SNQ	Frequency		
	Yes	No	Percentage (%)
Neck Pain	163	207	44.1
Shoulder Pain	75	295	20.3
Elbow Pain	44	326	11.9
Lower Back Pain	142	228	38.4
Hand/Wrist Pain	29	341	7.8
Knee Pain	12	358	3.2
Hip/Thigh Pain	16	354	4.3
Ankle/Feet Pain	9	361	2.4

TABLE 3. Chi-squared test for bivariate relation between MSD and demographics (N=370)

Variables	With MSD	Without MSD	p
Gender	50.0%	9.0%	<0.001
Age	36.8%	38.7%	0.03 (0.02 for trend)
Qualification	39.3	51.0	0.09
Working hours per day	47.2	40.8	0.08

TABLE 4. Comparison of frequency of MSDs with t -test after ergonomic interventions (N=141)

SNQ	Previous Frequency	New Frequency	p
Neck Pain	44.1%	21.4%	0.003
Shoulder Pain	20.3%	16.2%	0.49
Elbow Pain	11.9%	9.0%	0.11
Low Back Pain	38.4%	26.8%	0.16
Hand/Wrist Pain	7.8%	8.2%	0.25
Knee Pain	3.2%	2.1%	0.12
Hip/Thigh Pain	4.3%	2.1%	0.40
Ankle/Feet Pain	2.4%	1.2%	0.07

DISCUSSION

This research revealed an abundance of MSDs among dentists. Approximately 59.5% of all clinicians suffer from one or another form of MSD. Male dentists encounter more MSDs compared with female dentists, and senior dentists have fewer MSDs than younger ones. The intervention of ergonomic guidelines and exercises resulted in a significant reduction in MSDs among dental clinics. Most dentists participating in this study reported high frequencies of neck (44.1%) and lower back pain (38.1%). Shugars reported a similar MSD frequency of nearly 60%²⁶ and assessed the role of ergonomics in dentistry and its effect on MSD. According to Shugars, proper chair positioning and instrumentation could significantly decrease the fatigue and workload of dentists. Runderantz reported an MSD frequency of approximately 72% and found that prolonged static posture and awkward work positions are the leading cause of MSDs. Chowanadisai revealed MSDs in 78% of all dentists surveyed and proposed that ergonomic workplaces decrease stress and fatigue among dental professionals, leading to lower MSD incidence.²⁷ He also highlighted the need for exercises to be adjusted into a dentist's work schedule. In Pakistan, previous studies showed an MSD prevalence of approximately 74% among dentists.²⁸ This rate is higher than that found in the current study and other countries but less than those in Turkey and the USA^{9, 29} and even Nigeria (90.8%).³⁰ Finsenand Lehto found that 42% and 57.2% of their surveyed dentists have neck and shoulder pain, respectively.³¹ The occurrence of neck pain in the present study was 44.1%, similar to the findings of previous reports. Other researchers reported similar findings for neck pain prevalence in Greece (84%), Saudi Arabia (85%), and Australia (42%).^{17,32,33} After being provided awareness about ergonomics, 141 respondents (38.1%) out of 370 applied ergonomic changes in their workplace and reported significant results. Neck pain decreased from 44% to 21%, shoulder pain decreased from 20.8% to 13%, and lower back pain decreased from 38.4% to 26%. These results agree with the study reported by H.S. Bedi and colleagues, who used the define, measure, analyze, implement, and control (DMAIC) technique; after 3 months, however, only 23 out of 60 respondents applied ergonomics at their workplace.³⁴ The authors' study showed significant reductions in neck pain frequency from 47.8% to 21.7%, shoulder pain frequency from 39.1% to 17.3%, and elbow pain frequency from 26% to 21.7% (all $p < 0.05$); improvements in pain in other locomotor organs were also reported.

The wide range of improvements in MSD frequency reported can be attributed to the increased dissemination of knowledge via social media and improvements in product and equipment design. Certain interventions can prevent the development of MSDs. For example, a dentist should maintain an upright position,

thereby putting less pressure on the spine.¹⁴ The patient should be in a neutral position relative to the dentist, and the dentist's thighs should be under the dental unit, parallel to the floor. Instruments should not be over an arm's length away and are ideally within reach of the dentist. Instruments should also be kept sharp to reduce the need for excessive force.¹³ The unit light should be fully adjustable and provide shadow-free and focused illumination to the operating area. The dentist's stool should be adjustable and provide lumbar support. The dentist should change his posture and alternate between sitting and standing, perform exercises, and take microbreaks between patient appointments.²⁵ Certain guidelines have been provided by the FDI and ISO to maintain the appropriate dentist working position. Ergonomics can be applied to everyday practice by using the DMAIC technique.³⁴ Defining the problem is of great importance. Dentists usually work long continuous hours in a static sitting position and hold their arms in the abduction position. This position may lead to muscle fatigue and reduce blood flow to the muscles, gradually leading to drastic changes in muscle tissue, neuronal pressure, and the slow development of joint and spinal cord diseases. Questionnaires can be used to assess the extent of MSDs. Analysis of the data collected can be conducted, and the information obtained could be used to guide the necessary ergonomics implementations.

The high incidence of MSDs among dentists in Pakistan indicates the absence of ergonomically structured clinics; however, more research is needed to arrive at concrete conclusions. According to the 2017 census, Pakistan has a total population of 207 million, and the Pakistan Medical Commission indicates a total of 17,125 registered dentists.³⁵ The proportion of dentists to the public in Pakistan is 1:12,546, which is fairly low compared with the WHO recommendation of 1:8,500. Such a low ratio of dentists to patients creates a demand gap for oral health care and translates to increased loads on the dental workforce, which, in turn, reduce the health efficacy of dental practitioners. Ergonomics also come under the above-mentioned health efficacies. To provide dental services to large numbers of patients, dentists usually work long hours without breaks in less-than-ideal positions. The fatigue resulting from long hours of dental treatment may cause stress and reduce efficiency. In addition, pressure on body joints can cause devastating damage. Dentists suffering from a disease may be unable to treat patients and give them optimum care. The predisposing factors of MSDs are multifold and can be attributed to posture, movements, physical work, physical stress, and many other factors. The design of the present study prevents the identification of causal variables, and the subjectiveness of the replies may be considered an important constraint. Moreover, the small sample size could affect the generalizability of the results. A larger sample would improve the strength of this study.

CONCLUSIONS

In conclusion, MSD is very common among practicing dental surgeons. Dentists should be able to recognize MSDs and equip themselves by taking ergonomic measures to overcome this problem to improve their health and future. Chair-side muscle strengthening exercises should be routine in everyday practice. If a dentist is able to observe the sign and symptoms of MSD, he or she may be able to consult a physiotherapist before further issues develop. Awareness programs and workshops to promote ergonomics and exercises among dentists, with special focus on undergraduate students, should be created to highlight the importance of these activities in daily practice. Further research with longitudinal studies is needed to confirm the findings.

CONFLICT OF INTEREST

The authors declare no conflict of interest in this research.

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