

ORIGINAL ARTICLE

Assessment of the Understanding of Ergonomics Role in Triggering Musculoskeletal Pain Amongst Dentists of Karachi, PakistanASRA AFZAL¹, SHAISTA ZAFAR², FAIQA ASHFAQ³, JAVARIA JAVAID⁴, RAMSHA TAJ⁵, HASSAN MEHDI⁶^{1,2}BDS Dental Officer Fatima Jinnah Dental College³General Dentist (BDS,RDS) Dow University of Health Sciences⁴BDS, RDS Dow University of Health Sciences⁵Islamic International Dental College, Riphah International University, Islamabad⁶BDS, FCPS Oral Surgery, head of the department, Fatima Jinnah Dental CollegeCorrespondence to: Asra Afzal, Email: Asra_afzal@hotmail.com**ABSTRACT****Objective:** The purpose of the study is to assess the understanding of ergonomics role in triggering musculoskeletal pain amongst dental professionals in Pakistan.**Methodology:** A cross-sectional survey was carried out in hospitals and private clinics in Karachi. A total of 230 dentists were recruited in the study, 121 were males and 109 were females. Dentists aged between 27 years to 60 years with a clinical experience of minimum 5 years and no hereditary musculoskeletal disorder were included in the study. The questionnaire was divided into three segments recording; practice details, understanding of the work-related MSD and attitude towards WMSD. The collected data were computed and analyzed in SPSS.21.0.**Results:** According to the study 169 (73.5%) dentists claimed to have experienced musculoskeletal disorder pain. Lower back [4.77± 2.31] and neck [4.74± 2.23] followed by shoulder pain [4.93± 2.46] were the most common complaints. With respect to pain in different parts, female practitioners consistently reported more pain in every zone compared to males, irrespective of age. However, back pain reported the highest frequency with increasing BMI and decreased with age.**Conclusion:** The study showed a significant association of musculoskeletal pain with torsion/cervical flexion of the neck, employing for better approach during the procedures; however, with an increase in clinical experience the pain site changed from the lower back to wrist and hand, with respect to gender.**Keywords:** Dental professionals, Ergonomics, Lower back pain, Musculoskeletal pain.**INTRODUCTION**

Dentistry is a difficult calling, which requests a serious level of tolerance, massive focus, visual keenness and in particular upkeep of reasonable working stance for an extensive stretch. Inability to fight with or to adjust the functioning air can incline to injury or illness. Outer muscle issues, masochist side effects and cardiovascular infection add to exiting the workforce amongst dentists. Though in the new years, dentistry has seen important specialized progressions, still work-related medical problems/issues remain [1,2]. Clinical working circumstances frequently force a dental specialist to take on an unfortunate situation for a superior representation, which brings about solid torment and irritation that prompts outer muscle problem over a period [3-5]. Outer muscle problems (MSD) are an assortment of wounds or tissue-related harm to the muscle, joints and some other supporting design of the body [2]. MSD is pervasive all around the globe and is thought of as one of the commonest causes/reasons of long haul discomfort, pain and the handicap influencing a large number of people. This reality has been perceived by Joined Countries as well as World Wellbeing Association (WHO) with their endorsement of Joint and Bone ten years 2000-2010 [3]. MSD is described by handicap, presence of uneasiness, or tireless torment in ligaments, muscles, joints, and different parts, exasperated or brought about by the rehashed developments as well as drawn out abnormal or authorized body stances. Audits of Writing across the globe have uncovered high predominance of different MSD among dental specialists/dental professionals. Dental specialists take on static stances at their working environment which need in excess of half of their body's muscle to contract while opposing the gravity. Indeed, even in ideally situated stances, more noteworthy than one-half of their muscles are contracted statically, so there is minute development of their vertebral joints. MSD affects physical, social and mental perspectives of healthcare experts. Business-related MSD can bring about constant nonappearances and eventually early retirement [3-4]. Dental specialists worked in those conditions which typically created illnesses of outer muscle framework [5].

Hence, keeping a legitimate stance to forgo creating outer muscle problems is especially fundamental among dental practitioners [6]. Universally, the pervasiveness of outer muscle

problems among clinicians altogether influences their vocation, for example, early retirement, changing callings, expanded wiped out leave and diminished ability [7, 8]. Outer muscle problems (MSDs) are known to be a multi-factorial etiology; these issues chiefly happen because of delayed static stance, over the top powers application, one-sided weight on muscles, and utilization of vibrating instruments with unsupported raised arm. MSDs result in more prominent than 60% of all newly revealed work-related wounds. Human body isn't planned to moderate same body position or else involve in fine hand developments for, a large number of days or numerous hours. Dreary errand has been characterized by Silverstein, as "an undertaking that incorporates same basic development for more than or more half of work cycle. [9]. Work-related outer muscle problems (WMSDs) of furthest points are normal in addition to possibly debilitating, but preventable. 332,000 MSDs in light of rehashed injury were portrayed in U.S.A work environments in 1994, addressing around 65% of work-related illness cases answered to Agency of Work Measurements. [6]

Notwithstanding, socioeconomics and individual experience have likewise displayed to add to the irritation of business-related outer muscle issue (WMSD) among dental specialists. To limit MSDs, it has been prescribed to comprehend and carry out the ergonomic principles [10].

Specialists reported [11], a 73% commonness of WMSDs among dental experts for the most part toward the back and neck in their initial profession. Consequently, it was laid out that exact preparation and subordinate dental schooling empowers the dental specialist to utilize legitimate ergonomic stance. Notwithstanding, as far as anyone is concerned, restricted examinations have been directed in Pakistan among experienced dental specialists (over 5-years of clinical experience). Thus, the study aimed to assess understanding of ergonomics role in triggering musculoskeletal pain among dental professionals in Karachi, Pakistan.

MATERIAL AND METHODS

Ethical consideration: After the drafted protocol was reviewed and approved by the Institutional Ethical Review Committee, the dental surgeons were recruited into the study. Each of them was provided with informed consent before participating in the study.

Each participant was given the right to withdraw from the study at any point without any consequences.

Study Design and participants:The present study was a cross-sectional design, conducted under the standards in the Helsinki declaration (1964) in the different dental hospitals and private clinics in Karachi, Pakistan. The study recruited general dental practitioners practicing in hospitals and private clinics during the period from June 2019 to February 2020. A total of 230 surgeons; both male and female were selected by non probability purposive sampling technique in the study based on a designed inclusion and exclusion criteria. Sample size was calculated by;

$$n = Z^2 P (1 - P) / d^2$$

Where n is the sample size, Z is the statistic corresponding to level of confidence, P is expected prevalence (that can be obtained from similar studies)

Inclusion and exclusion criteria: Dentists aged between 27 years to 60 years with a clinical experience of a minimum of 5 years and no hereditary musculoskeletal disorder were included in the study. Dentist with any immunocompromised diseases were excluded from the study. Both genders were included in the study. Whereas, dentists aged less than 27 years and greater than 60 years with a clinical experience of fewer than 5 years and any reported hereditary musculoskeletal disorder were excluded from the study.

Data Collection: After marking the educated assent, every member was given a self-revealed survey evaluating the work practice and comprehension of the specialists with respect to the ergonomics guideline. Members who griped of agony were additionally approached to finish up independent torment evaluation outlines. Assessment of torment was finished involving a numeric scale in relationship with delineations utilizing diagrams.

Questionnaire:The questionnaire was assessed three different areas of dental surgeons understanding and attitude in clinical practice; practice details, understanding of the WMSD and response towards WMSD.

The primary segment comprised of bio-information and segment. The subsequent segment depended on questions connected with work factors including normally rehearsed methods, working hours out of every day, number of breaks during strategy, instrumentation, vision procedure (immediate or backhanded), and utilization of loupes. The third segment involved questions connected with agony and position including impact because of purpose of vibratory instruments or gadgets, cervical flexion for development of vision, practice after any dental method, expert interview for torment, impact on systems and any utilization of prescription.

Data analysis: Data were analyzed using SPSS version 21 (Chicago, IL, USA). The categorical variables were expressed in frequencies and percentages whereas the quantitative variables were displayed using mean, and standard deviations. ANOVA was performed to compare and correlate the study groups to identify the evident causative factor influencing the WMSD at 95% Confidence Interval, considering $p \leq 0.05$ as significant.

RESULTS

Demographics: A total of 318 questionnaires were distributed to dentists working in various hospitals and private clinics. Out of 318 questionnaires, 230 dentists (162 in hospitals and 68 in private clinics, respectively) agreed to fill out the questionnaire. Out of which 121 (52.6%) were males and 109 (47.4%) were females.

Table 1: demographics of the study groups

		Mean Pain	Standard deviation
Gender	Male	3.16	3.29
	Female	3.76	2.81
BMI	Underweight	2.36	2.33
	Normal	3.59	3.46
	Overweight	3.17	2.82
	Obese	3.78	2.36
Age	27-34	3.34	3.16
	35-42	3.89	2.96
	43-50	2.57	2.40
	51-58	4.00	3.34
	>59	3.43	3.40
	Clinical Experience	5	3.70
5-8		3.02	2.43
9-12		3.65	2.77
13-16		3.12	2.94
>16		3.52	2.95

Table 2: Work Associated Factors

		Mean Pain	Standard deviation	Anova
Working hours per day	1-4 Hours	3.06	2.63	0.313
	5-8 Hours	3.61	2.84	
	9-12 Hours	3.25	3.79	
	13-16 Hours	4.00	1.41	
Working position	Sitting	3.44	3.18	>0.01
	Standing	3.31	2.76	
	Both	5.50	1.91	
Which vision do you Mostly prefer for Maxillary arch	Direct	3.41	2.80	>0.01
	Indirect	3.59	3.53	
	Both	3.33	2.77	
Do you use loupes	Yes	3.36	2.61	>0.01
	No	3.47	3.21	
	Sometimes	3.42	2.94	
Cervical flexion to Improve vision	Yes	3.62	2.74	0.030
	No	3.13	3.60	
Short breaks between Long procedures	Yes	3.45	3.09	>0.01
	No	3.42	3.07	
Stretching exercises After working	Yes	3.70	2.63	0.021
	No	3.20	3.45	

Table 3: Body sites of pain distribution

Pain Distribution		
Zones	Mean	Standard Deviation
Neck	4.74	2.233
Shoulder	4.93	2.463
Upper back	5.62	3.593
Lower back	4.77	2.310
Hand & wrist	4.79	2.208
Elbow	5.56	2.603
Hips and thighs	6.22	2.728
Knee	5.71	2.690
Ankle and feet	4.92	2.253

Table 4: correlation between demographic and zone of pain

		Zone of pain										Anova
		Neck		Shoulder		Upper back		Lower back		Hand & wrist		
		Mean	St.d	Mean	St.d	Mean	St.d	Mean	St.d	Mean	St.d	
Gender	Male	1.32	2.10	0.76	1.71	0.78	1.75	1.64	2.42	0.48	1.46	0.018
	Female	1.98	2.64	1.39	2.50	0.88	2.18	2.17	2.86	0.79	1.70	
Bmi	Underweight	1.27	2.05	0.73	1.34	0.00	0.00	1.45	2.54	0.73	1.34	0.4
	Normal	1.66	2.40	1.04	2.22	0.64	1.69	1.81	2.64	0.50	1.35	
	Overweight	1.59	2.36	1.14	2.17	0.79	1.98	2.06	2.75	0.57	1.54	
	Obese	1.33	2.16	0.56	1.33	1.78	2.64	2.22	2.37	0.33	0.76	
Age	27-34	1.51	2.30	1.09	2.16	0.86	2.02	1.82	2.63	0.61	1.43	>0.01
	35-42	2.11	3.89	1.24	2.41	0.98	2.10	1.85	2.57	0.95	2.17	
	43-50	1.29	1.49	0.57	1.22	0.14	0.53	1.86	2.53	0.80	0.00	
	51-58	1.33	2.06	1.00	1.67	1.00	2.44	3.00	3.52	0.33	0.81	
	>59	1.43	2.50	0.00	0.00	0.00	0.00	2.57	3.40	0.00	0.00	
	5	1.56	2.54	1.37	2.46	0.99	2.23	2.00	2.72	0.55	1.42	
Clinical experience	5-8	1.66	2.27	0.94	1.94	0.79	1.93	1.40	2.42	0.87	1.59	<0.01
	9-12	1.65	2.54	1.04	2.09	0.83	2.00	1.96	2.61	0.74	1.99	
	13-16	1.60	2.38	0.40	1.63	0.88	1.83	1.52	2.40	0.40	1.63	
	>16	1.76	2.16	1.09	2.06	0.48	1.41	2.61	2.97	0.42	1.20	

Table A.1 highlights the demographics of the study groups. The mean age of the participants was 34.17 years (± 7.84). In males, the mean age was 35.83 (± 8.704) whereas, in females, the mean age was 32.32 (± 6.299). The mean BMI of the participants was 24.321 \pm 3.807 with males mean BMI 25.017 (± 3.576) and females 23.516 (± 3.925), respectively. The outcomes pointed out, 73 (31.7%) participants had the clinical experience of 5 years, 53 (23.0%) practiced for 5-8 years, 46 (20.0%) for 9-12 years, 25 (10.9%) for 13-16 years and 33 (14.35%) had experienced greater than 16 years. Similarly, 129 (56.1%) dentists reported working 5-8 hours per day, 64 (27.8%) dentists worked 9-12 hours and 32 (13.9%) dentists worked only 1-4 hours per day.

Work factor assessment: Tables A .2 shows the effect of the work factor on dental experts. Evaluating the rehearsed hard working attitudes among the dental specialist, 165 (71.7%) detailed enjoying short reprieves during long systems, while, 65 (28.3%) were not for enjoying any reprieves during strategies. Further to assess the generally impacted side of the specialists, 220 (95.7%), favored right-given dentistry, and 10 (4.3%) were left-given. Concerning favored position, 174 (75.7%) dental specialists liked to work while sitting, though, 52 (22.6%) preferred a straight position.

As for clinical practice, 154 (67%) dental specialists ceased from utilizing dental loupes contrasted with 28 (12.2%) utilizing loupes. Subsequently, because of ill-advised situating and impeded vision during methods, 147 (63.9%) members performed cervical twist/flexion for a superior methodology, rather than 83 (36.1%) who didn't. Furthermore, only 88 (38.3%) answered to involve backhanded vision for maxillary curve treatment while, 41 (17.8%) favored involving direct mirror vision in many examples. Regardless, least agony was accounted for in 112 (48.7%) dental specialists who extended and practiced after the systems contrasted with 118 (51.3%) who didn't. In this manner, the discoveries featured the ostensible comprehension of hard working attitudes among the dental specialist.

Examining the aggravation evaluation, 169 (73.5%) dental specialists detailed experiencing outer muscle issue torment though, 61 (26.5%) were without torment. Out of the people who endured MSD, 152 (66.1%) members overlooked the agony and side effects as opposed to 52 (22.7%) dental specialists visited counsel once or at least a time or two. Among these dental specialists, 116 (50.4%) keep away from medicine for MSD related side effects, though, just 5 (2.2%) consistently took drug for their outer muscle torment. This alluded to the absence of affirmation of the significance of WMSD among the dental specialist.

As far as zone of torment, the majority of dental specialist revealed torment in one of the parts including; 96 [4.77 \pm 2.31] lower back torment, 94 neck torment [4.74 \pm 2.23], 58 shoulder torment [4.93 \pm 2.46], 42 upper back torment [5.62 \pm 3.59], elbow agony 9 [5.56 \pm 2.60] and knee torment 7 [5.71 \pm 2.690]. Besides, barely any dental specialists revealed torment in more than one section, for example, 38 [4.79 \pm 2.20] in hands and wrist torment, 13 lower leg and feet torment [4.92 \pm 2.25], and 9 hip and thigh torment [6.22 \pm 2.728] (table: A 3). In this manner, the discoveries called attention to normal serious agony grievances in the lower back torment (8.2%), trailed by neck torment (5.2%) to be generally resulted because of ill-advised work positions.

The dental's comprehension specialist might interpret the aggravation was surveyed, which uncovered 64 (27.8%) didn't relate outer muscle issue agony to a particular strategy. Notwithstanding, 42 (18.3%) accepted endodontic systems were essentially liable for inspiring problems, 27 (11.7%) dental specialists related torment with the utilization of vibratory instruments and 29 (12.6%) expected extraction strategies as most frequently guilty. Accordingly, demonstrating the ostensible comprehension of causative component for MSD among the dental specialist.

Correlation of pain with demographics: Statistically, females were identified as more susceptible to MSD pain than males ($p=0.018$). 88 female dentists [3.76 \pm 2.81] reported higher MSD related pain compared with 81 males [3.16 \pm 3.29]. However, age, BMI, clinical experience, working position, use of dental loupes during procedures and taking short breaks during long procedures did not produce significant statistical variation in their relationship to MSD related pain (table: A 4).

With respect to position, 78.2% of the surgeons who employed cervical flexion/torsion for indirect vision or improved approach proved a significant impact on the severity of the pain as opposed to 65.1% who did not ($p=0.030$). Moreover, despite the high number of reported working hours, statistically, there was no correlation proven with regards to pain elicitation ($p=0.313$). However, interestingly, those who performed stretching exercises after procedures were statistically more likely ($p=0.021$) to report MSD related pain (80.4% vs. 66.9%).

With respect to pain, female practitioners consistently reported more pain in every zone compared to males. Upper and lower back pain reported the highest frequency with increasing BMI. Whereas, hand and wrist problems tended to decline with an increase in BMI with hand pain (22.0%) reported twice more than wrist pain (11.6%). However, interestingly, a statistically significant correlation was found between hand and wrist with increasing clinical experience ($p=0.022$). Nevertheless, there was no significant co-relation of age with any particular anatomical zone for MSD (table A 4).

DISCUSSION

The present study investigated to assess the understanding of ergonomics role in triggering musculoskeletal pain among dental professionals working in hospitals and private setups. The current review uncovered a high pervasiveness of outer muscle torment among dental experts with a pitiful degree of mindfulness in regards to the causative component as for orientation and BMI. The dental situating was recognized as a significant hotspot for inspiring the MSD regardless old enough. Accordingly, the invalid speculation can be totally dismissed.

Work is the main source of Outer muscle disorder (MSD) among dental experts worldwide [11]. More noteworthy utilization of exorbitant powers, stirred stance and firm situation for long-span are the essential variable liable for Outer muscle torment [12, 13]. Connecting with the discoveries of Rehman et al [14], most of dental experts taking part in the review were male demonstrating the transcendence of male orientation in clinical practice; be that as it may, the MSD was accounted for in most of females. It was interesting that the female's sensitive body outline neglects to bear the pressure because of truly difficult work or while the use of additional power during the systems. Likewise, Lindfors et al [24], detailed 83% of females endured MSD due to psychosocial factors while 74% of guys go through more actual pressure. Subsequently, the creators laid out that the MSD is chiefly reliant upon the aggravation edge, muscle volume, and hormonal changes that trigger aggravation insight [21, 25-27].

The most pervasive age bunch in our review went from 27-34 years demonstrating a more noteworthy level of outer muscle torment in this age bunch. Relating with past examinations, MSD's high predominance in this youthful class is reminiscent of over responsibility in the dental arrangement, defective ergonomics and erroneous methodology during the treatment [15, 14]. Alghadir et al [15], revealed that MSD emerging in the youthful expert is a disturbing sign; thus, with expanding age, there is plausible the issue develops and makes trouble to additional proceed with the training. Be that as it may, our were steady with past examinations directed in Australia, Lithuania, Turkey, and the Czech Republic, showing no relationship among's age and experience [17-20]. By the by, debate actually exists as Rafie et al found a higher

predominance of chest area torment mirroring the kind of training in Iran [21].

Harmonizing with the Rehman et al discoveries [14], the review demonstrated that the locale generally connected with outer muscle torment was the lower back followed by neck agony and shoulder torment. Dental specialist spent extended periods slouched over patients with unsupported rest and raised the shoulder at additional the 30-degree kidnapping or flexion that puts weight on muscles of the lower back and shoulders [31-34, 37]. This diminishes oxygen levels in the muscles, which delays the static compression of the lumbar erector spinae and assembles lactic corrosive in the tissues bringing about torment [28,38]. All the while, steady sitting and utilization of hand vibratory instruments with redundant developments at a support of the ring finger puts a consistent burden on the finger and wrist, causing unnecessary strain prompting carpal passage syndrome [13, 39-44]. Be that as it may, a concentrate in Poland showed contradicting discoveries demonstrating high torment predominance in the sacral locale 76.9%, and cervical district 66.6% [29]. Consequently, it very well may be laid out that the distinction in clinical practice and preparing impacts the site of agony advancement.

As indicated by our review dental specialists performing customary extending practices had an opposite relationship with the outer muscle issue; be that as it may, no connection was seen between the dental loupes and vision position for disconnected region of the mouth with outer muscle torment. It was accounted for that bowing and turning of their necks for better vision prompted delicacy and muscle unbending nature between the shoulders [13, 31, 38]. Consequently, following Alghadir et al [15] discoveries, the review upholds the possibility that clinical experience works with the dental specialist to utilize a superior methodology during techniques with time, for example, a dental mirror and utilizing dental loupes brings about less agony and distress. Consequently, the review laid out that with expanding age and long stretches of involvement outer muscle issue diminishes.

Inside the impediments, the review recognized that the functioning position played a significant contributing variable in setting off WMSD regarding orientation, BMI and clinical experience. What's more, the experts exhibited a huge distinction in discernment connected with clinical work on showing the requirement for legitimate preparation and direction. Nonetheless, it is relevant to make reference to that evaluation expects to be directed on a more drawn out follow-up period to foster the preventive methodologies to diminish the business related MSD among dental specialists. Besides, there is an opportunity of predisposition in oneself detailed polls, as every individual's discernment shifts connected with their own encounters; subsequently, future examinations are expected for predictable discoveries.

Limitations: Sample size is small. Work burden of each dental professional is not calculated. Level of education of participants is not compared.

CONCLUSION

The study showed a significant association of MSD with females, torsion/cervical flexion of neck during dental procedures and hand and wrist with increasing clinical dental experience. A high prevalence of MSD in the study is suggestive of the need for proper training programs for dental practices. Thus, it is important to promote and introduce preventive programs regarding ergonomic posture.

Acknowledgements: The authors would like to thank to Dr Waqas Yousuf, Dr Moiz Khan, Dr Mohsin Javed, Dr Mustafa and Dr Alizay for their time and cooperation.

Disclaimer: None to declare.

Conflict of interest: None to declare.

Funding sources: None to declare.

REFERENCES

- Pirvu C, Axante A, Preoteasa C, Părlătescu I, Cărămidă M, Pirvu D. Maintaining a Balanced Posture by Dentists—A Challenge of the Current Practice. *Timisoara Med.* 2021 Dec;20(2):1-13.
- Velasquez-Plata D. Practical Considerations in Incorporating Microsurgery to Daily Workflow. In *Microsurgery in Periodontal and Implant Dentistry 2022* (pp. 153-170). Springer, Cham..
- Chan VC, Ross GB, Clouthier AL, Fischer SL, Graham RB. The role of machine learning in the primary prevention of work-related musculoskeletal disorders: A scoping review. *Applied Ergonomics.* 2022 Jan 1;98:103574.
- Pandey S, Chouksey A, Pitakpatapee Y, Srivanitchapoom P. Movement Disorders and Musculoskeletal System: A Reciprocal Relationship. *Movement Disorders Clinical Practice.* 2022 Feb;9(2):156-69..
- Ohlendorf D, Naser A, Haas Y, Haenel J, Fraeulin L, Holzgreve F, Erbe C, Betz W, Wanke EM, Brueggmann D, Nienhaus A. Prevalence of Musculoskeletal Disorders among Dentists and Dental Students in Germany. *International Journal of Environmental Research and Public Health.* 2020 Jan;17(23):8740.
- Ali LI, Eltayeb EM. Risk factors of musculoskeletal problems among dentists in Khartoum locality, Khartoum state. *MAR Dent Sc.* 2022;4(6):1-6..
- Bonfiglioli R, Caraballo-Arias Y, Salmen-Navarro A. Epidemiology of work-related musculoskeletal disorders. *Curr Opin in Epid and Public Hlth.* 2022 Nov 1;1(1):18-24..
- Calatayud J, Morera Á, Ezzatvar Y, López-Bueno R, Andersen LL, Cuenca-Martínez F, Suso-Martí L, Sanchis-Sánchez E, López-Bueno L, Casaña J. Importance of frequency and intensity of strength training for work ability among physical therapists. *Scien Reprts.* 2022 Sep 2;12(1):1-7.
- d'Errico A, Falkstedt D, Almroth M, Badarin K, Hemmingsson T, Kjellberg K. Long-term sick leave for back pain, exposure to physical workload and psychosocial factors at work, and risk of disability and early-age retirement among aged Swedish workers. *Inter Arch of Occupatnl and Environ Hlth.* 2022 Apr 22:1-5.
- Mulimani P, Hoe VC, Hayes MJ, Idiculla JJ, Abas AB, Karanth L. Ergonomic interventions for preventing musculoskeletal disorders in dental care practitioners. *Cochrane Database of Systematic Reviews.* 2018; (10): 1-39
- Capodaglio EM. Participatory ergonomics for the reduction of musculoskeletal exposure of maintenance workers. *Inter J of Occup Safety and Erg.* 2022 Jan 2;28(1):376-86.
- Soares CO, Pereira BF, Gomes MV, Marcondes LP, de Campos Gomes F, de Melo-Neto JS. Preventive factors against work-related musculoskeletal disorders: narrative review. *Revista Brasileira de Medicina do Trabalho.* 2019;17(3):415-30.
- Caballero-Bruno I, Wohlbebe T, Töpfer D, Hernández-Castellano PM. The effect of seating recline on sleep quality, comfort and pressure distribution in moving autonomous vehicles. *Appl Erg.* 2022 Nov 1;105:103844.
- Rehman K, Ayaz H, Urooj W, Shah R. Work-related musculoskeletal disorders among dental practitioners in Khyber Pakhtunkhwa. *Pakistan Oral & Dental Journal.* 2013;33(3).
- Alghadir A, Zafar H, Iqbal ZA. Work-related musculoskeletal disorders among dental professionals in Saudi Arabia. *J Phys Ther Sci J Phys Ther Sci.* 2015;27(4):1107-12..
- Rabiei M, Shakiba M, DEHGAN-SHAHREZA H, Talebzadeh M. Musculoskeletal disorders in dentists. *Int j of occup hyg.* 2015;4(1):36-40.
- Kierklo A, Kobus A, Jaworska M, Botulinski B. Work-related musculoskeletal disorders among dentists—a questionnaire survey. *Ann Agric Environ Med Ann Agric Environ Med* 2011;18(1).
- Batham C, Yasobant S. A risk assessment study on work-related musculoskeletal disorders among dentists in Bhopal, India. *Indian J Dent Res.* 2016;27(3):236.
- Koneru S, Tanikonda R. Role of yoga and physical activity in work-related musculoskeletal disorders among dentists. *J Int Soc Prev Community Dent.* 2015;5(3):199.
- Hodacova L, Sustova Z, Cermakova E, Kapitan M, Smejkalova J. Self-reported risk factors related to the most frequent musculoskeletal complaints among Czech dentists. *Indus hlth.* 2015;53(1):48-55.
- Rafie F, Zamani Jam A, Shahravan A, Raouf M, Eskandarizadeh A. Prevalence of upper extremity musculoskeletal disorders in dentists: symptoms and risk factors. *Environ Sci pub Health.* 2015;2015.
- Gupta A, Bhat M, Mohammed T, Bansal N, Gupta G. Ergonomics in dentistry. *Int J Clin Pediatr Dent.* 2014;7(1):30-23.
- Meisha DE, Alsharqawi NS, Samarah AA, Al-Ghamdi MY. Prevalence of work-related musculoskeletal disorders and ergonomic practice

- among dentists in Jeddah, Saudi Arabia. *Clin Cosmet Investig Dent.* 2019;11:171.
24. Lindfors P, Von Thiele U, Lundberg U. Work characteristics and upper extremity disorders in female dental health workers. *J occup hith.* 2006;48(3):192-7.
 25. Cho K, Cho H-y, Han G-S. Risk factors associated with musculoskeletal symptoms in Korean dental practitioners. *J Phys Ther Sci J Phys Ther Sci.* 2016;28(1):56-62.
 26. Tang KH. The Prevalence, Causes and Prevention of Occupational Musculoskeletal Disorders. *Glob Acad J Med Sci.* 2022;4.1-6.
 27. Chidi-Ogbolu N, Baar K. Effect of estrogen on musculoskeletal performance and injury risk. *Front in physio.* 2019 Jan 15;9:1834.
 28. Lamott A. *Muscular System, Pathologies, Disorders, and Injuries. Massage Therapy E-Book: Principles and Practice.* 2022 Oct 28:438-.
 29. sakzewski L, Naser-ud-Din S. Work-related musculoskeletal disorders in dentists and orthodontists: a review of the literature. *Work.* 2014;48(1):37-45.
 30. Sardar KP, Khan RF, Kumar K, Zaidi AB. Work-related musculoskeletal pain among dental students at Dow University of Health Sciences, Karachi. *JOPDAK.* 2014 Jul;23(03):117-21.
 31. Rolander B, Forsman M, Ghafouri B, Abtahi F, Wählin C. Measurements and observations of movements at work for warehouse forklift truck operators. *Inter J. Occu Saf and Erg.* 2021 Jul 29:1-9..
 32. <https://www.spineuniverse.com/wellness/ergonomics/back-care-dentists-surgeons> April 2, 2019 (accessed on Jan 24, 2022)
 33. Moodley R, Naidoo S, van Wyk J. The prevalence of occupational health-related problems in dentistry: A review of the literature. *J Occup Health.* 2018;60(2):111-25.
 34. Khan RS, Ahmad F, Merchant MS. Prevalence of work related musculoskeletal disorders (MSD) among dentists. *Intern J Contemp Med Research.* 2017;4(5):1208-11..
 35. Hayes MJ, Smith DR, Taylor JA. Musculoskeletal disorders and symptom severity among Australian dental hygienists. *BMC research notes.* 2013;6(1):250.
 36. Saleem T, Zainab SN, Bhatti UD. Prevalence of Causative Factors For Musculoskeletal Disorders and Their Awareness Amongst Dental Surgeons. *Pak Oral & Dent J.* 2015;35(2).
 37. Afridi S, Jamil B, Gilani SI. Frequency of musculoskeletal pain dentist working in public and private sector dental hospitals of Peshawar. *JPD.* 2012;21(4):187-97.
 38. Rambabu T, Suneetha K. Prevalence of work related musculoskeletal disorders among physicians, surgeons and dentists: a comparative study. *Ann Med Health Sci Res.* 2014;4(4):578-82.
 39. Ehsan M, Ehsan S, Arshad H. Frequency of carpal tunnel syndrome in dentists working in government hospitals of lahore. *Int J Sci Res.* 2016; 5 (5):1672-75.
 40. Khan Aa, Siddiqui Az, Ahmed Mr, Askari H, Zahid A. Prevalence of Carpel Tunnel Syndrome in The Dentists Working in Karachi. *Pak Oral Dent J.* 2014;34(4).
 41. Feng B, Chen K, Zhu X, Ip WY, Andersen LL, Page P, Wang Y. Prevalence and risk factors of self-reported wrist and hand symptoms and clinically confirmed carpal tunnel syndrome among office workers in China: a cross-sectional study. *BMC Public Health.* 2021 Dec;21(1):1-0.
 42. Meisha DE, Alsharqawi NS, Samarah AA, Al-Ghamdi MY. Prevalence of work-related musculoskeletal disorders and ergonomic practice among dentists in Jeddah, Saudi Arabia. *Clin, Cosmet and Investig Dent.* 2019;11:171-79.
 43. Al Shahrani E, Al Shahrani A, Al-Maflehi N. Personal factors associated with carpal tunnel syndrome (CTS): a case-control study. *BMC Musculoskeletal Disorders.* 2021 Dec;22(1):1-7.
 44. Alhusain FA, Almohrij M, Althukeir F, Alshater A, Alghamdi B, Masuadi E, Basudan A. Prevalence of carpal tunnel syndrome symptoms among dentists working in Riyadh. *Ann Saudi Med.* 2019 Mar;39(2):104-11.