



# Effectiveness of an educative ergonomic plan in reducing musculo-skeletal disorders among dental practitioners

Efetividade de um plano ergonômico educativo na redução de distúrbios osteomusculares entre dentistas

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## ABSTRACT

**Objective:** Work related musculo skeletal disorders (WMSD) are very common among dental practitioners who use precise hand-wrist motions and prolonged static postures. The aim of this study was to develop an educative ergonomic plan and test its effectiveness in reducing symptoms of musculo-skeletal disorders among dental practitioners. **Material and Methods:** This study was conducted on a random sample of 50 dental practitioners of both genders (25 male, 25 female) practising for more than 4 years in urban Bengaluru, India and showing symptoms of neck pain, back pain or wrist pain. In the first round of the questionnaire data was collected from all 50 dentists. Next an educative ergonomic plan was developed which included simple exercises and recommendations in the form of do's and don'ts. The study population were asked to follow the guidelines given and perform the exercises given in the poster daily for a period of 3 months. Then, the questions were again asked. The differences in responses during the first stage and second stage were analyzed. **Results:** The use of the ergonomic plan led to a statistically significant improvement in certain ergonomic practises such as practise of changing their positions during clinical practice, keeping shoulders and arm at correct level while working and keeping instruments within hand reach. There was a statistically significant reduction in pain levels after the use of the ergonomic plan. **Conclusion:** The ergonomic plan in the form of recommendations and exercises were an effective tool in improving ergonomic practises and reducing the symptoms of musculoskeletal disorders among dental practitioners.

## KEYWORDS

Ergonomics; Musculoskeletal disorders; Wrist pain; Back pain; Neck pain.

## RESUMO

**Objetivo:** Distúrbios osteomusculares relacionados ao trabalho (DORT) são muito comuns entre os dentistas que usam movimentos precisos de mão e punho e posturas estáticas prolongadas. O objetivo deste estudo foi desenvolver um plano ergonômico educativo e testar sua eficácia na redução de sintomas de distúrbios osteomusculares em dentistas. **Material e Métodos:** Este estudo foi realizado em uma amostra aleatória de 50 dentistas de ambos os sexos (25 homens, 25 mulheres) trabalhando há mais de 4 anos na área urbana de Bengaluru, Índia e apresentando sintomas de dor no pescoço, dor nas costas ou dor no punho. Na primeira etapa do questionário foram coletados dados de todos os 50 dentistas. Em seguida, foi desenvolvido um plano ergonômico educativo que incluía exercícios simples e recomendações na forma de fazer e não fazer. Os participantes foram solicitados a seguir as orientações dadas e realizar os exercícios indicados no pôster diariamente por um período de 3 meses. Em seguida, as perguntas foram feitas novamente. Foram analisadas as diferenças nas respostas durante a primeira etapa e a segunda etapa. **Resultados:** A utilização do plano ergonômico levou a uma melhora estatisticamente significativa em algumas práticas ergonômicas, como a prática de mudar de posição durante o atendimento clínico, manter ombros e braços no nível correto durante o trabalho e manter os instrumentos ao alcance das mãos. Houve redução estatisticamente significativa dos níveis de dor após a utilização do plano ergonômico. **Conclusão:** O plano ergonômico na forma de recomendações e exercícios foi uma ferramenta eficaz na melhoria das práticas ergonômicas e na redução dos sintomas de distúrbios osteomusculares entre os cirurgiões-dentistas.

## PALAVRAS-CHAVE

Ergonomia; Distúrbios osteomusculares; Dor no punho; Dor nas costas; Dor no pescoço.

## INTRODUCTION

Ergonomics is defined as a set of multidisciplinary knowledge applied to the organisation of labour activities and elements that make up a job [1]. In Greek, “ergo” means work and “nomos” means natural laws or systems [2]. Ergonomics modifies the work to meet the needs of people, rather than forcing people to accommodate the work [2]. The clinical practise of dentistry requires a great amount of clinical skill as well as theoretical knowledge. The clinical skills in dentistry are developed through years of practise and this practise entails fine motor skills and repeated movements of the clinician’s hand, wrist, neck, back etc [1,3]. Dentistry itself demands a compromised working posture owing to the fact that the working area has limited access and indirect vision is often used [4,5]. There is always a neutral zone of movement for every joint and muscle. Injury risks increase whenever work requires a person to perform tasks with body segments outside of his or her neutral range in a deviated posture [6]. Musculo skeletal disorders (MSD) or work related musculo skeletal disorders (WMSD) are very common among dental practitioners who use precise hand-wrist motions and prolonged static postures. Spine, shoulders, elbows and hands are the most likely areas of the body to be involved [7]. WMSD refers to signs and symptoms arising due to series of micro traumas to bones, joints, ligaments, muscle tendons, blood vessels and nerves that accumulate and are intensified by work [8]. The onset of these MSDs can progress to a severe condition if care is not taken at a proper time. A systematic review focusing mainly on the pain experience found that the prevalence of WMSD in dentists ranged as high as 64% and 93% [9]. Musculoskeletal disorders account for 29.5% of the reasons for early retirement among dentists [10].

It has been suggested that injuries caused by WMSD, or similar cumulative trauma disorders, can be reduced or prevented by applying ergonomics in dental equipment and instrument design [11]. Adjusting the patient’s chair when accessing different quadrants, placing instruments and materials within easy reach, working with elbows lower than shoulders have been advised to improve posture in a clinical environment thus minimizing fatigue and the risk of developing WMSD [12]. Several detailed guidelines have been provided to diagnose and prevent MSD among

dentists [2,5]. This should be part of the education curriculum for dental students. Although the condition is common, there is very low awareness about methods to prevent them [1]. The reporting of musculoskeletal symptoms by dental students as early as the first year of the dental program suggests that ergonomics should be covered and taught as part of the dental curriculum to reduce risks of WMSD in the future [8]. A majority of students (92%) reported minimum participation in workshops related to ergonomics in dentistry and 77% were unfamiliar with treatment and remedies available in the case of WMSD [8]. Students have also reported to have knowledge regarding ergonomics and are aware of its importance for occupational health. However, they have difficulty adopting ergonomic postures [13]. Therefore, ergonomics improvements, health promotion and institutional interventions are needed for reducing the risks for WMSD. Hence there is a need to improve the knowledge and practices among students and dentists. It has also been recommended to perform specific exercises for trunk, shoulder, hands, head and neck on regular basis to prevent these disorders [14].

The aim of this study was to develop an educative ergonomic plan in the form of a poster with exercises and recommendations and to test its effectiveness in reducing musculo-skeletal disorders among dental practitioners in urban Bangalore, India.

## METHOD AND MATERIALS

The study was a questionnaire study with convenience sampling method conducted over a period of 3 months. A random sample of 50 dental practitioners of both genders (25 male, 25 female) who were willing to participate in the study were considered. Inclusion criteria were: Dentists practising for more than 4 years in urban Bengaluru and showing symptoms of neck pain, back pain or wrist pain. Exclusion criteria were practitioners who were under any pain medication, pregnant, suffering from any medical conditions like bone disorders, hypothyroidism, and with a history of trauma, fracture of wrist, etc.

The questionnaire was prepared by consulting specialists (Orthopedician and Physiotherapist) in the field. In the first part of the study, the 50 dental practitioners selected were given the questionnaire. The questionnaire is shown in Table 1.

**Table 1 - QUESTIONNAIRE**

1. Name: _____ Age: _____
2. Gender: M <input type="checkbox"/> F <input type="checkbox"/>
3. Are you familiar with the ergonomic posture to perform clinical procedures in your dental practice?
YES <input type="checkbox"/> NO <input type="checkbox"/>
4. Do you experience any musculoskeletal pain due to dental practice?
YES <input type="checkbox"/> NO <input type="checkbox"/>
5. During which activity/activities do you experience pain?
Endodontics <input type="checkbox"/>
surgery <input type="checkbox"/>
periodontics <input type="checkbox"/>
restorative <input type="checkbox"/>
orthodontics <input type="checkbox"/>
prosthodontics <input type="checkbox"/>
6. Mark in which region you feel pain:
Back <input type="checkbox"/>
Shoulder <input type="checkbox"/>
Wrist <input type="checkbox"/>
Neck <input type="checkbox"/>
Hand <input type="checkbox"/>
7. Rate your pain below accordingly:
0-2 <input type="checkbox"/> 2-5 <input type="checkbox"/> 5-10 <input type="checkbox"/> >10 <input type="checkbox"/>
(1: mildest and 10: most severe)
8. Do you experience pain during or after using vibrating instruments (high speed handpiece)?
YES <input type="checkbox"/> NO <input type="checkbox"/>
9. Do you consider that you have sufficient light at your work place?
YES <input type="checkbox"/> NO <input type="checkbox"/>
10. Do you have enough space in your work place?
YES <input type="checkbox"/> NO <input type="checkbox"/>
11. Do you work with your legs slightly separated?
YES <input type="checkbox"/> NO <input type="checkbox"/>
12. Do you support yourself on your feet's sole when working?
YES <input type="checkbox"/> NO <input type="checkbox"/>
13. Do you frequently change your positions during your clinical practice?
YES <input type="checkbox"/> NO <input type="checkbox"/>
14. Do you keep your shoulders and arm high while working?
YES <input type="checkbox"/> NO <input type="checkbox"/>
15. Do you find your work stool comfortable?
YES <input type="checkbox"/> NO <input type="checkbox"/>
16. Do you consider the dental stool you are using for clinical practice can ergonomically regulated for individual need?
YES <input type="checkbox"/> NO <input type="checkbox"/>
17. When initiating your practice, do you position your chair to maintain an ergonomic posture?
YES <input type="checkbox"/> NO <input type="checkbox"/>
18. Are you able to change your work posture seating or standing during your practice
YES <input type="checkbox"/> NO <input type="checkbox"/>
19. Do you keep your arms at sternum height while working
YES <input type="checkbox"/> NO <input type="checkbox"/>
20. After finishing clinical practice do you perform stretching exercises
YES <input type="checkbox"/> NO <input type="checkbox"/>
21. Are the instruments within your hand's reach?
YES <input type="checkbox"/> NO <input type="checkbox"/>
22. Have you ever taken any treatment for your MUSCULO SKELETAL DISORDER? If yes specify.
YES <input type="checkbox"/> NO <input type="checkbox"/>

In the next stage of the study an ergonomic plan (educative poster including exercises and recommendations) was developed.

Initially a review was done of the literature on musculoskeletal disorders and ergonomics among dentists from pubmed and scopus indexed journals, reference books and other authentic sources.<sup>1-10</sup> The information was critically reviewed to summarize practical techniques and exercises for better ergonomics. An educative poster was developed which included simple exercises and recommendations in the form of do's and don'ts. The poster was validated with subject experts. An orthopedic surgeon and a physiotherapist were consulted for validation. Method used for validation was PEMAT-P (Patient Education Materials Assessment tool for printable materials [15]. The contents of the poster was as follows- (exercises and recommendations)

#### WRIST EXERCISES:- Figure 1

A) Spider push up - Start with your hands together in prayer position. Spread fingers apart as far you can, then separate your palms and bring fingers together. Repeat ten times.

B) Stretch Armstrong – Place one arm straight out in front of you, elbow straight, with your wrist extended and palm and fingers facing the floor. Use your other hand to apply gentle pressure to the downward-facing hand, stretching your wrist and fingers. Repeat the same for other hand. Repeat 5 times.

#### EXERCISES FOR LOWER BACK:- Figure 1 & 2

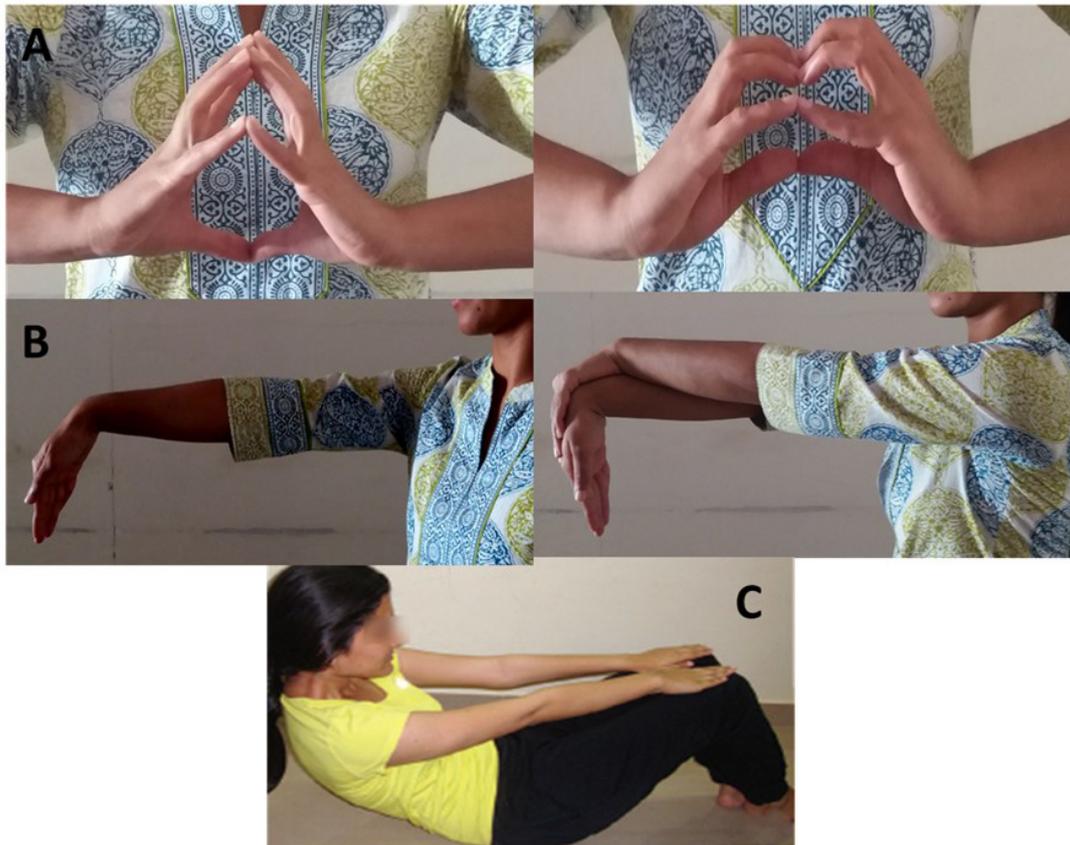
C) Partial curl – (Figure 1) Lie on the floor with knees bent and feet flat. Keep your neck relaxed and extend your arms straight to the sides of your hips. Raise your shoulders off the floor until you feel the stretch, hold for 3 seconds, and then slowly lower to the floor. Repeat 10 times.

D) Back stretch – (Figure 2) Stand straight with both the feet close to each other, raise your hands, bend forward to touch the toes without bending the knees and then stand straight and bend backward slightly. Try doing at least 10 repetitions.

#### EXERCISES FOR NECK (Figure 2)

E) HEAD TILT- Slowly tilt your head toward your right shoulder while keeping your left shoulder down. Hold this position for 5 to 10 seconds. Repeat the same for left side. Repeat 5 times.

F) HEAD ROTATION- Slowly turn your head to the right, keeping your chin straight. Hold this



**Figure 1** - Exercises. A- spider push up, B- Stretch Armstrong, C- partial curl.

position for 5 to 10 seconds, then return to centre. Do the same for left side. Repeat 5 times.

Recommendations for practise were as follows and were provided with the poster-

**DO'S** -Maintain erect posture during clinical practice. Head must be tilted between 0-15 degrees only and not more. Position the adjustable light to avoid strain on the neck. Lean slightly forward from the waist or hips. Adjust the work stool based on the height of patient and your back position. Alternate work positions between sitting, standing and side of the patient. Keep shoulders in relaxed position. Consider horizontal patient position.

**DONT'S** - Avoid arching of your back. Avoid lifting shoulders in strained position. Don't keep patient's chair too high. Avoid tilting head to one side only for longer durations. Avoid overflexion of the spine. Avoid working with elbow too high in relation to shoulder. Avoid extreme wrist deviation from side to side. Avoid excessive wrist movements.

Once the poster and recommendations were prepared the next stage the study was conducted. The study sample were given the poster prepared



**Figure 2** - Exercises. D- Back stretch, E- Head tilt, F-Head rotation.

and the ergonomic recommendations. The study design is shown in Figure 3. The study group of 50 dentists were asked to follow the guidelines given and perform the exercises given in the poster daily for a period of 3 months. At the end of this phase, the dentists were again asked to answer the questionnaire. The differences in responses during the first stage and second stage were analyzed and are presented. The compliance of following the plan was recorded in a chart.

The data collected was saved in an excel chart. Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 released 2013, Armonk, NY: IBM Corp., was used to perform the statistical analyses. Descriptive analysis of all the explanatory parameters was done using frequency and proportions. Mc Nemar's test applied for comparison of responses to various questions among the study participants during pre & post intervention period. The level of significance was set at  $P < 0.05$ .

## RESULTS

Table 2 present the distribution of study participants according to age. 62% were in the age range of 20-30 years.

In this study 94.0% of the sample reported that they were familiar with the ergonomic postures to perform clinical procedures in dental practice at the pre intervention phase. 70% of

the sample reported that they were had some musculoskeletal pain due to dental practice at the pre intervention stage but after the intervention this number increased to 87.5%. The difference was not statistically significant. Table 3 presents the area or region where they felt pain.

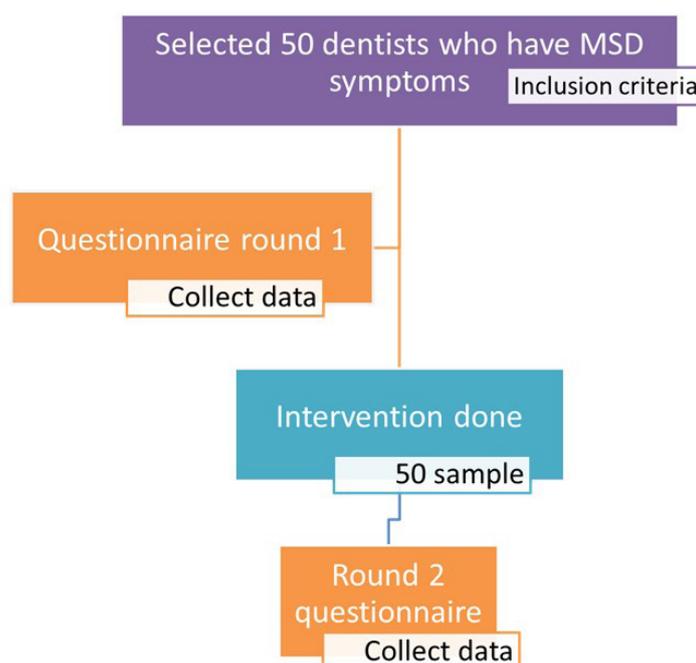
Table 4 shows the rating of the pain levels.

16% of the sample experienced pain during or after using vibrating instruments (high speed handpiece) and even after the intervention there was no statistically significant difference in this response. 32 subjects (64%) reported that they frequently change their positions during clinical practice and this changed to 48 samples after the intervention and this change was statistically significant as seen in Table 5.

30% of the sample reported that they kept their shoulders and arm high while working and this changed to 22.2% after the intervention and this change was statistically significant as seen in Table 6.

**Table 2** - Distribution of Study Participants According To age

Age in years	Frequency	Percent
20-30	31	62.0
31-40	12	24.0
41-50	5	10.0
61-70	2	4.0
Total	50	100.0



**Figure 3** - Study design.

**Table 3** - The area or region where they felt pain

			Post					Total
			Back	Shoulder	Wrist	Neck	hand	
pre	Back	Count	15	1	1	6	2	25
		%	83.3%	16.7%	12.5%	60.0%	25.0%	50.0%
	shoulder	Count	1	5	0	0	2	8
		%	5.6%	83.3%	0.0%	0.0%	25.0%	16.0%
	wrist	Count	1	0	5	0	1	7
		%	5.6%	0.0%	62.5%	0.0%	12.5%	14.0%
neck	Count	0	0	1	4	1	6	
	%	0.0%	0.0%	12.5%	40.0%	12.5%	12.0%	
hand	Count	1	0	1	0	2	4	
	%	5.6%	0.0%	12.5%	0.0%	25.0%	8.0%	
Total	Count	18	6	8	10	8	50	
	%	100.0%	100.0%	100.0%	100%	100%	100%	

p value-0.242

**Table 4** - Rating of pain levels

			Post			Total
			0-2	2-5	5-10	
Pre	0-2	Count	24	0	0	24
		%	61.5%	0.0%	0.0%	48.0%
	2-5	Count	12	10	0	22
		%	30.8%	100.0%	0.0%	44.0%
	5-10	Count	3	0	1	4
		%	7.7%	0.0%	100.0%	8.0%
Total	Count	39	10	1	50	
	%	100.0%	100.0%	100.0%	100.0%	

p value-0.001\*

**Table 5** - Q13- Do you frequently change your positions during your clinical practice

			Post		Total
			yes	no	
Pre	yes	Count	32	0	32
		%	66.7%	0.0%	64.0%
	no	Count	16	2	18
		%	33.3%	100.0%	36.0%
	Total	Count	48	2	50
		%	100.0%	100.0%	100.0%

p value-0.000\*

**Table 6** - Q14-Do you keep your shoulders and arm high while working?

			Post		Total
			yes	no	
Pre	yes	Count	5	10	15
		%	100.0%	22.2%	30.0%
	no	Count	0	35	35
		%	0.0%	77.8%	70.0%
	Total	Count	5	45	50
		%	100.0%	100.0%	100.0%

p value-0.002\*

The responses to questions 16, 17, 18 and 19 in the questionnaire did not give much differences when comparing the pre and post intervention data. Only 22% of the sample reported that after finishing clinical practice they performed stretching exercises at the pre intervention stage. This changed to 70.3% after the intervention and this change was statistically significant as seen in Table 7.

72% of the sample reported that their instruments were within hand reach and they didn't make strenuous movements before the intervention and this changed to 76.6% after the intervention and this change was statistically significant as seen in Table 8.

## DISCUSSION

As shown in Table 2 the age distribution of study participants varied from 20 to 60 years and majority were in the age range of 20-30 years. The sex distribution was equal. Hence this study focussed on younger practitioners with a minimum of 4 years of experience.

94.0% of the sample reported that they were familiar with the ergonomic postures to perform clinical procedures in dental practice

at the pre intervention phase and this changed to 100% of the sample at the post intervention phase. This showed that the participants were conscious of the increase in their knowledge on the topic as a consequence of participating in this study. The probable reasons for not following the ergonomic practises earlier could be a poor understanding of ergonomics theory; a gap between the theoretical discipline and its clinical application; and a working environment unsuitable for ergonomically correct dental work [1]. Our study correlates to another study where it was found that knowledge of ergonomics postural requirements and their clinical application among the dental students surveyed were not satisfactory [1]. In another study among dental students in Malaysia they found that majority of students (92%) reported minimum participation in workshops related to ergonomics in dentistry and 77% were unfamiliar with treatment and remedies available. They also advised that theory and practice of ergonomics should be incorporated into the dental undergraduate curriculum [8]. Our study also made similar recommendations based on findings among dental practitioners in India. In another study done it was found that 84.6% of all students surveyed suffered from

**Table 7** - Q20-After finishing clinical practice do you perform stretching exercises

			Post		Total
			yes	no	
Pre	yes	Count	11	0	11
		%	29.7%	0.0%	22.0%
	no	Count	26	13	39
		%	70.3%	100.0%	78.0%
	Total	Count	37	13	50
		%	100.0%	100.0%	100.0%
p value-0.000*					

**Table 8** - Q21-Are the instruments within hand reach without making strenuous movements?

			Post		Total
			yes	no	
Pre	yes	Count	36	0	36
		%	76.6%	0.0%	72.0%
	no	Count	11	3	14
		%	23.4%	100.0%	28.0%
	Total	Count	47	3	50
		%	100.0%	100.0%	100.0%
p value-0.001*					

MSD associated with the clinical requirements of their training [16]. This finding suggests that oral health professionals may have an increased risk of developing MSD during their education and training, well before the beginning of a professional career. There is a requirement for the inclusion of ergonomics in the dental curriculum, and also stressing theoretical knowledge and practical implication during various dental procedures [17].

A statistically significant reduction in pain levels was seen after the use of the ergonomic plan. This reduction was seen across the participants who had higher pain levels (between 5-10). This suggests that the combination of ergonomic exercises and practise recommendations is an effective method to reduce the symptoms of MSD among practitioners and this suggestion is supported by similar literature [5]. A probable reason for this effectiveness could be that the poster was prominently displayed in the clinical area which acted as a reminder to the clinicians to follow the principles. Hence development of an exercise regimen such as that used in this study should prove to be a significant factor in reducing these disorders. Such practises ought to be ingrained in the training and curriculum. It is important to highlight this issue as WMSD in dentistry might contribute considerably to sick leave, reduced productivity and future possibility of leaving the profession at an early age [18].

The limitations of this study is that it had a small sample size based on convenience sampling and a cross sectional design and hence cannot relate specific practises to development of MSDs. The data collected relied on self-reporting by the dentists and could lead to over or under estimation of the pain and the related injuries or recall bias. Compliance was checked using self-assessment in a chart but there could have been bias in reporting of compliance.

## CONCLUSION

The ergonomic plan in the form of recommendations and exercises were an effective tool in improving ergonomic practises and reducing the symptoms of musculoskeletal disorders among dental practitioners. There is a requirement for the inclusion of ergonomics in the dental curriculum.

## Author's contribution

SS, SM: conceptualization and methodology. SS, RG, PM, SG, SG: data curation, writing - original draft preparation.

## Conflict of Interest

There is no conflict of interest.

## Funding

The authors declare that no financial support was received.

## Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of Ethical Committee review board, FDS, RUAS. The approval code for this study is: UG2019/15.

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