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Review Article

Ergonomics and Musculoskeletal Health in Dentistry: A Review Article

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ABSTRACT:

The physically demanding nature of dentistry, combined with prolonged static and awkward working postures, contributes significantly to the rising prevalence of work-related musculoskeletal disorders (WMSDs) among dental professionals. A well-designed dental operatory and adoption of balanced working postures are essential for minimizing physical strain and optimizing procedural accuracy. Thisnarrative review discusses the theoretical foundations of dental ergonomics, the implications of poor posture, and practical strategies for incremental ergonomic improvements.By increasing awareness and promoting preventive interventions, it becomes possible to guide practitioners toward safer, more sustainable work habits that support both their physical well-being and long-term professional performance.

Keywords: Musculoskeletal Pain, Dental Professionals, Occupational Health, Ergonomics, Postural Discomfort, Musculoskeletal Disorders (MSDS), Balanced Posture.

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INTRODUCTION

Dental practice requires repetitive tasks, refined motor skills, and the maintenance of static postures for extended periods, often in restricted clinical environments. These working conditions impose substantial physical strain on dental professionals, predisposing them to musculoskeletal disorders (MSDs), persistent pain, and overall fatigue.Like many occupations, dentistry carries its own set of occupational risks, thereby highlighting the relevance of ergonomics. Ergonomics focuses on adjusting the working environment to suit human capabilities, rather than forcing individuals to adapt to poorly designed systems. Performing dental procedures demands a high level of precision and skilled control[1]. The muscles engaged during such tasks are susceptible to fatigue, leading to physical discomfort for the practitioner[2]. These cumulative biomechanical stresses contribute significantly to the prevalence of work-related musculoskeletal disorders (WMSDs), especially in areas like the neck, shoulders, lower back, and wrists. This risk is particularly pronounced in specialties such as Conservative Dentistry and Endodontics, where clinicians often perform lengthy, focused procedures with restricted movement and fine instrumentation, increasing the likelihood of chronic pain and postural stress[3]. In response, ergonomic tools such as magnification aids (e.g., loupes and microscopes), saddle stools, and posture-supportive devices are gaining traction in both clinical and academic domains. Nevertheless, a consistent and widespread adoption of ergonomic practices in daily dental routines is still lacking[4].

Musculoskeletal disorders: Impaired muscles, bones, joints, and surrounding connective tissues are the hallmarks of musculoskeletal disorders, which can cause short-term or long-term functional and participation limitations. These are usually characterized by discomfort, which is frequently chronic, and dexterity and movement restrictions, which limit a person's capacity to work and engage in society. According to a 2010 study by Hill et al., MSDs are among the most prevalent and significant reasons why dentists retire early[5]. The back and neck are the areas most commonly impacted by

musculoskeletal pain, which affects 64% to 93% of dentists[2]. Reduced strength, pain, swelling, and numbness are among the initial symptoms. Weak hand grasp, hypersensitivity in the hands and fingers, and extreme neck and shoulder tiredness are possible additional symptoms.Sustained awkward postures often lead to stressed and fatigues muscles which can become ischemic and exert asymmetrical forces causing misalignment of the spinal column[6].

TYPES OF MSDS

- Trapezius Myalgia which refers to pain and stiffness in the upper trapezius muscle, often associated with neck and shoulder pain.
- Non-specific / Mechanical Low Back Pain which occurs mostly due toProlonged static posture or sitting.
- Disc herniation which occurs mostly due to Prolonged sitting in unsupported or poor postures, Twisting the torso while reaching or rotating during procedures, forward bending of the lumbar spine for extended durations.
- Vibration exposure can cause carpal tunnel syndrome (CTS), a nerve-related condition that mostly affects the wrist's median nerve. Both vigorous and repeated work have been connected to CTS. There is proof that extremely repetitive employment, either by itself or in conjunction with other factors, is linked to CTS.
- De Quervain's Tenosynovitisiscaused by inflammation and swelling of the tendons and their sheaths, specifically the abductor pollicis longus and extensor pollicis brevis tendons, leading to pain, tenderness, and difficulty moving the thumb[7].

Prevalence of Work-Related Musculoskeletal Disorders (WMSDs) in Dentistry: Work-related musculoskeletal disorders (WMSDs) are among the most prevalent occupational health concerns in dentistry. Multiple studies report a high prevalence of WMSDs among dental professionals, ranging from 64% to 93%[6]. Most commonly affected regions include the neck (up to 75%), lower back (65%), and shoulders (45%), largely due to sustained forward-leaning posture and limited trunk mobility during procedures[8].The prevalence of MSDs in the general population in India is about 7.08%. In some studies it has been found that Endodontists posses highest prevalence (88.20%) of Work-related musculoskeletal disorder as compared to all other branches[9]

Risk Factors of Work-Related Musculoskeletal Disorders (WMSDs) in Dentistry: The occurrence of work-related musculoskeletal disorders (WMSDs) among dental professionals is influenced by a range of interrelated factors. During routine clinical practice, dentists are exposed to various physical, mechanical, and psychosocial demands[10]. These stressors act collectively over time, leading to increased musculoskeletal strain. This risk is especially pronounced in fields such as Conservative Dentistry and Endodontics, where practitioners frequently perform prolonged and highly precise procedures[5].

Inadequate Posture: When lifting, lowering, or handling objects with the back bent or twisted, the spinal discs are subjected to more pressure than when the posture is neutral and upright. In a similar way, wrist, hip, knee, and shoulder strains are increased by prolonged or repetitive bending or twisting motions.Tasks carried out at or above shoulder height for extended periods are particularly taxing and can lead to accelerated muscular fatigue. Due to various clinicaldemands, dental professionals often find themselves in such awkwardpositions[6]**(Figure 1)**. These include the need to:

Coordinate efficiently with the dental assistant,
Maintain clear visibility of the oral cavity,
Ensure the patient's comfort, and
Handle intricate equipment or retrieve instruments positioned nearby.

Common faulty postures in dentistry include the “Turtle Neck Posture”, where the head protrudes forward past the shoulderstypically observed in dentists leaning in for visibility. Another is the “Hunched Back Posture”, involving upper back rounding or thoracic kyphosis, a result of frequent bending over patients. The “Chicken Wing Posture” occurs when clinicians abduct their elbows away from the body due to a lack of proper arm support during procedures. These sustained misalignments place continuous stress on the musculoskeletal system, elevating the risk for chronic pain and functional impairment[11].

Fig 1: Inadequate posture

Repetitive Motions and Prolonged Static Positions: Dental procedures require ongoing, repetitive use of the fingers and wrists, especially during tasks such as instrumentation and root canal preparation—often carried out without sufficient micro-breaks[12]. When combined with prolonged static postures, these repeated movements can lead to overuse of stabilizing muscle groups and increased stress on joints. As reported by Halkai et al., maintaining static positions for extended durations is one of the major contributing factors to lower back pain and shoulder strain in dental practitioners[13].

Use of Vibrating Tools and Equipment: Regular use of vibrating dental instrumentsincluding ultrasonic scalers, endodontic motors, and handpiecescan contribute to vibration-related fatigue and potential injury to soft tissues[14]. Extended exposure to hand-arm vibrations has been associated with vascular disturbances, nerve irritation, and musculoskeletal issues like carpal tunnel syndrome. Research highlights the ergonomic benefits of incorporating modern dental microscopes and lightweight rotary systems to help minimize these risks.[15]

Psychosocial Stressors and Fatigue: Psychological stress, time pressure, and patient anxiety contribute indirectly to musculoskeletal issues. Dentists under constant pressure may neglect proper posture, skip breaks, or overexert during procedures. Fatigue from long clinical hours diminishes muscular endurance, making the body more susceptible to strain and microtrauma[16].

Preventive Strategies: Preventing work-related musculoskeletal disorders (WMSDs) in dentistry demands a comprehensive and preventive strategy. Embedding ergonomic principles into both education and clinical routines is crucial for minimizing physical stress, supporting long-term professional health, and ensuring consistent patient care standards. The strategies outlined below are evidence-based interventions that have been shown to effectively reduce musculoskeletal risks among dental practitioners[17].

1. Operatory Design and Chair Ergonomics

An ergonomically designed operatory reduces unnecessary movements and postural imbalance. Key aspects include:

Use of adjustable operator stools, ideally designed with a convex backrest and a negative seat tilt that raises the pelvis to an angle of 110°–125°, placing it above knee level, is recommended. Since the arms contribute roughly 5% of total body weight, proper arm support can significantly reduce muscular strain in the neck and shoulder region[18].

When working under a dental microscope, the seat tilt should remain within 110°–130°, encouraging a slight forward pelvic rotation to help maintain the lumbar curve and reduce lower back stress. A backrest angle of 100°–110° allows a subtle recline, lowering spinal disc pressure. Knees should be slightly below the hips, and elbows bent at 90°–100°, with forearms fully supported—preferably using armrests—to alleviate upper limb fatigue[19].

Saddle-style chairs help align the pelvis properly, improving blood and lymphatic flow while maintaining neutral spinal posture.

The rheostat pedal should be positioned close to the operator, with the knee flexed at about 90°–100°. The heel remains on the floor, while only the forefoot activates the pedal. Alternating foot use 2–3 times daily helps reduce repetitive strain.

Placing patients in a fully reclined (supine) position enables operators to maintain ergonomic posture. The chair height should be adjusted to ensure free leg movement underneath. Pirvu et al. recommend

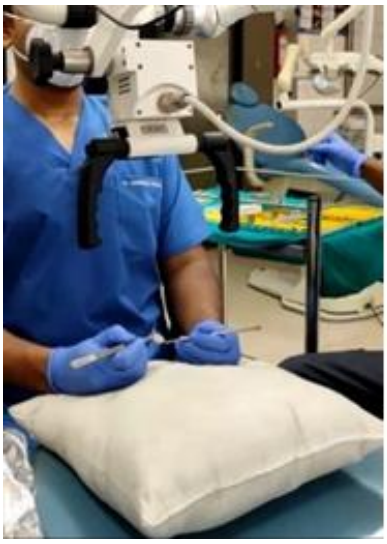
keeping a distance of 35–40 cm between the operator's eyes and the patient's oral cavity for optimal visual access without compromising posture[7].

Ideal Ergonomics for Operator

- Head**:** The ears should be aligned vertically with the shoulders, and the line of sight should remain at or slightly below the horizon—ideally between 0° and 20°downward**.**
- Shoulders**:** Must remain in line with the hip axis**,** avoiding elevation or forward rounding.
- Arms**:**They should be positioned close to the body with ≤20° arm abduction, ≤25° forward reach from the shoulder, and elbow angles of 90°–120° to minimize muscle strain. Valachiand Neuhaus et al. highlighted their role in reducing musculoskeletal risk and improving operator accuracy and endurance.
- Forearms**:** Should be parallel to the floor or angled upward by no more than 15°, and must rest comfortably on arm supports to reduce muscular strain.
- Hips: Positioned higher than the knees, maintaining an angle between 110° and 125° to encourage proper pelvic tilt and spinal alignment.
- Thighs: Should be angled apart no more than 30° and aligned with the feet**,** maintaining symmetry for balanced weight distribution[20].

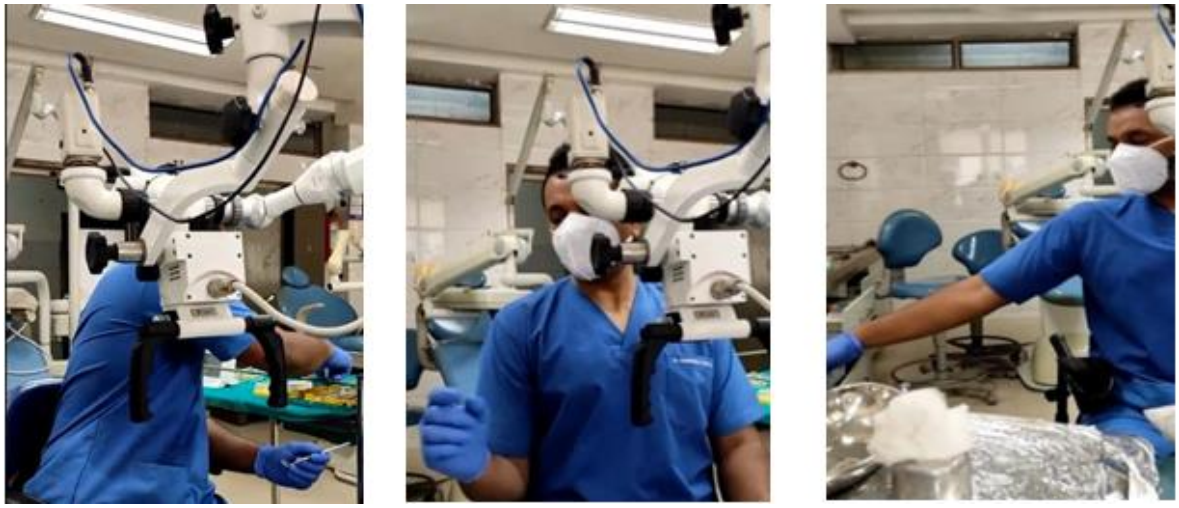
Table 1: Classification of Movements in Ergonomics (Class I to V)[21](Figure 2)

Class	Movement Type	Body Parts Involved	Description	Examples in Dentistry
Class I	Finger movements only	Fingers	Most precise and least fatiguing movements	Picking up a probe or scaler using fingers only
Class II	Finger and wrist movements	Fingers and wrist	Slightly more effort; minimal range of motion	Transferring small instruments between fingers
Class III	Finger, wrist, and elbow movements	Hand, wrist, forearm	Moderate range and effort; still efficient	Reaching for instruments on a nearby tray
Class IV	Whole arm movement from the shoulder	Shoulder and full arm	Requires more effort; less efficient	Reaching across the patient or across the dental unit
Class V	Movement involving the entire torso/body	Entire body (torso, legs, arms)	Most fatiguing and least efficient; should be minimized	Standing up, walking across operatory, twisting the body



Class 1

Class 2

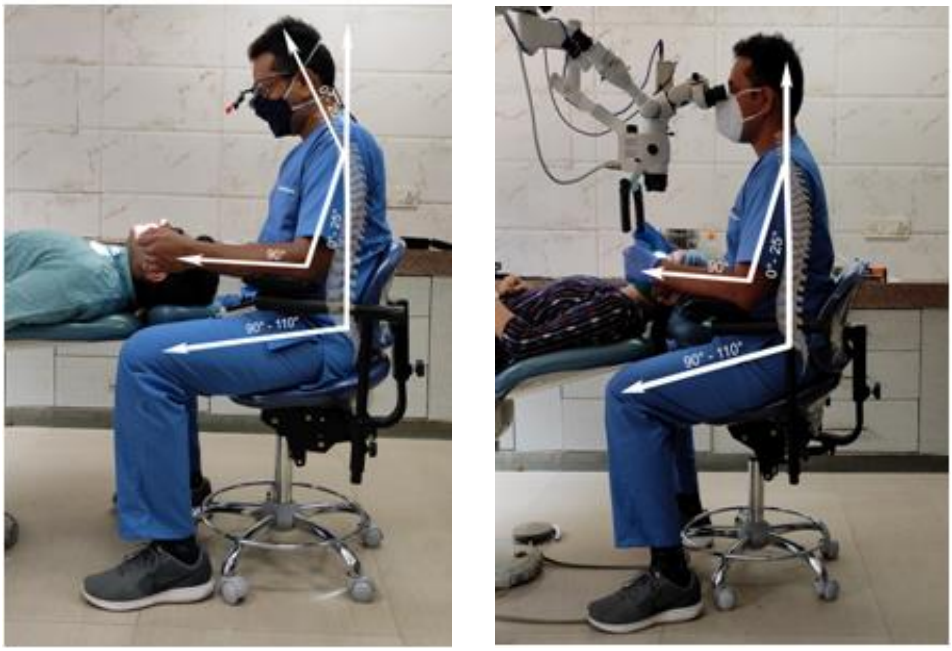


Class 3 **Class 4** **Class 5**

Figure 2: Classification of Movements in Ergonomics

2. **Role of Magnification Systems (Loupes and Microscopes):** Magnification tools, including dental loupes and operating microscopes, are essential for improving both clinical accuracy and operator posture. These devices enhance visibility of the treatment area, enabling clinicians to maintain a more upright and neutral head-neck alignment, which helps to minimize excessive forward bending during procedures.

In dentistry, Through-The-Lens (TTL) loupes and flip-up loupes are two commonly used magnification systems, each with distinct ergonomic implications. TTL loupes have the optics permanently fixed into the eyepiece frame, offering a lighter weight, better balance, and fixeddeclination angle, which is the downward tilt of the optics relative to the horizontal line of sight.This lowers the chance of cervical spine discomfort by encouraging a more neutral head and neck posture. Flip-up loupes, on the other hand, are detachable and adjustable, which makes them adaptable and shareable among operators. They can move the center of gravity forward, are usually heavier because of hinges and have a less steep declination angle which can be changed, which causes more forward head tilt and neck flexion. The declination angle is a critical ergonomic factor. Steeper angles (ideally 35°–45°) helpto maintain an upright posture by minimizing the need for neck flexion. Poorly designed or improperly adjusted loupes with shallow declination angles (<25°) are associated with increased incidence of musculoskeletal disorders in the neck and upper back[22]. Dental loupes with appropriate working distance and declination angle can significantly decrease cervical strain, while microscopes offer superior illumination and magnification without compromising posture and eye strain as it offers coaxial illumination and better focus. Integrated Coaxial lightening Provides shadow-free illumination along the optical axis, Ensures uniform brightness and Supports neutral posture[23].In loupes, Galilean optics offer lighter weight and wider fields of view with lower magnification, reducing strain during shorter procedures. In contrast, prismatic (Keplerian) optics provide higher magnification and better depth perception but may increase visual fatigue due to narrower fields and greater accommodation demand. Operating microscopes, incorporating prismatic optics and advanced coaxial illumination, offer superior image clarity and ergonomic viewing, significantly reducing ocular fatigue during prolonged or microsurgical procedures.**(Figure 3)**



Ergonomics under loups **Ergonomics under Microscope**

Fig 3: Ergonomics Under Loups and Microscope

3. **Hand instruments:**While there is no universally accepted definition of an ergonomically ideal hand instrument, certain design elements have been shown to reduce user strain. Round handles are generally favored over hexagonal designs, as they lessen muscle load and decrease the chance of nerve compression[22]. However, completely smooth round handles may demand greater pinch force to prevent slippage. Incorporating textured surfaceslike knurling or groovesenhances grip and reduces the amount of force needed. In contrast, narrow hexagonal handles can increase stress on the fingers. Moreover, keeping instrument tips sharp is important, as it reduces the force needed during use, helping to limit muscle fatigue[24].
4. **Break Scheduling, Stretching, and Physical Fitness:** Incorporating regular microbreaks throughout clinical practice has been shown to help relieve muscular fatigue. Performing stretching exercises targeting the neck, shoulders, and lower back promotes flexibility and improves circulation, helping to prevent stiffness and repetitive strain injuries[13]. Halkai et al. emphasize the importance of including daily physical activity, such as yoga or core-strengthening routines, to enhance endurance and better tolerate prolonged static postures during dental work[9].**(Figure 4)**

Fig 4: Stretching Exercises

5. **Four handed dentistry:** Four-handed dentistry is designed to reduce unnecessary movements by allowing the dental assistant to support the operator by managing instruments and materials, thereby limiting excessive motion of the dentist's arms, hands, and body, which helps prevent physical fatigue and injury[24]. For effective ergonomic practice, instruments and equipment should be strategically positioned close to the assistant to ensure quick and easy access. Delivery systems such as over-the-head or over-the-patient configurations are particularly advantageous, as they allow the assistant to handle tasks like bur changes and instrument exchange more efficiently[17]. Core elements of four-handed dentistry include seamless instrument transfer, effective suction and retraction, maintaining a focused working zone, and ensuring all tasks involve minimal operator movement[25].
6. **Six handed dentistry:** While working under the microscope six handed dentistry becomes a refined clinical workflow that enhances efficiency, visibility, and ergonomics. In this technique, three team membersthe dentist, a primary assistant, and a secondary assistantwork in coordination. While the operator focuses on precise, magnified procedures through the dental microscope, the first assistant manages suction, irrigation, retraction, and instrument transfer within the visual field, maintaining an aseptic and uninterrupted working area. The second assistant supports peripheral tasks such as mixing materials, preparing instruments, and managing documentation, ensuring the operator and first assistant can maintain a sterile field and optimal focus. This setup minimizes operator movement, reduces procedure time, and allows the clinician to maintain a neutral posture, which is critical under magnification[19].

Zones of Activity: The work area around the patient is basically divided into four zones called "zones of activity."Zones of activity are identified using the patient's face as the face of a clock.

The four zones of activity are asfollows:

- Operator's zone
- Assistant's zone
- Transfer zone
- Static zone[25]

Different activity zones for the right operator are shown in Figure 5.

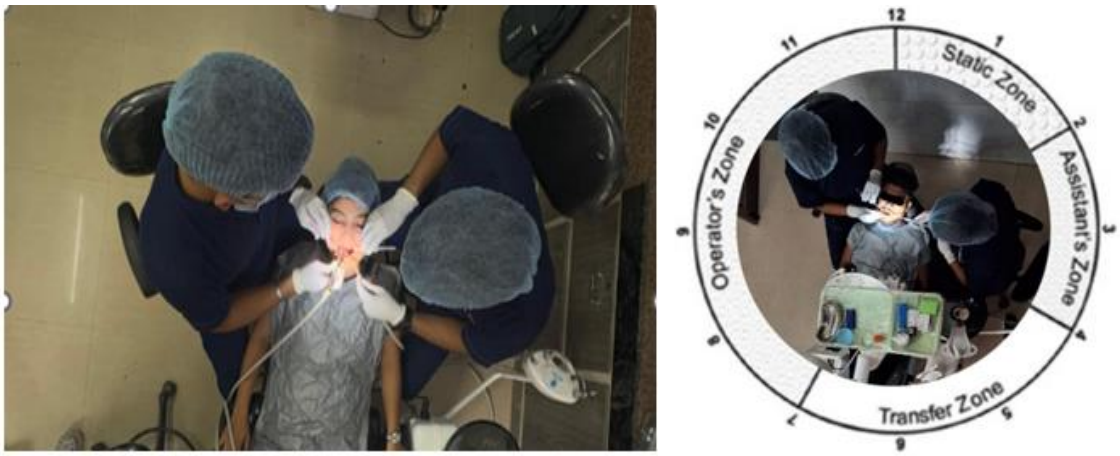


Fig 5: Four Handed Dentistry and Zones of Activity

The Circle of influence: The circle of influence of ergonomics in dentistry refers to the interconnected system of elements that directly or indirectly shape how ergonomic principles are applied and sustained within the clinical environment. It begins with the operator at the center, whose posture, movements, and working habits drive ergonomic needs. Surrounding this are layers of influence, including equipment design (dental chair, stool, microscope), clinical environment layout (instrument zones, lighting, operatory size), and assisting systems (four- or six-handed dentistry). Further layers involve institutional policies, training programs, and professional culture**(Figure 6)**.

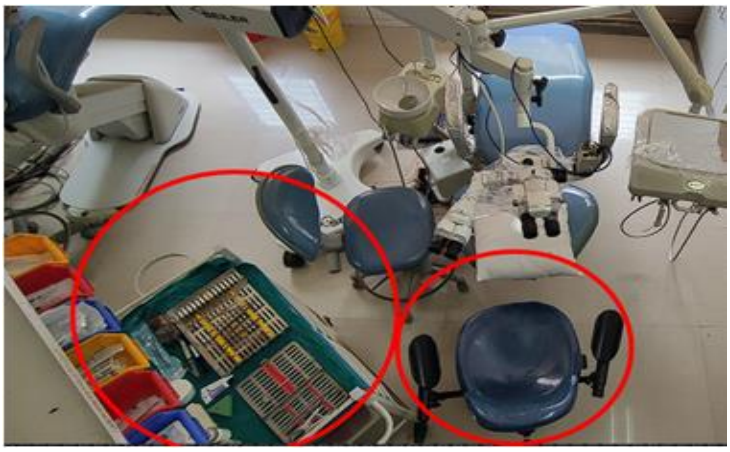


Fig 6: Circle of influence

Proper Temperatures: In the dental work environment, low room temperatures, handling of cold instruments or materials, and exposure to cold air exhaust can lead to reduced finger temperatures. Although no formal standard exists for optimal finger temperature, it is generally recommended to maintain hand and finger temperatures above 25°C (77°F) to preserve dexterity and grip strength.[26]

CONCLUSION

Dentists may spend up to 60,000 hours in ergonomically challenging positions over their careers, often resulting in musculoskeletal disorders. The physical demands of dentistry make practitioners susceptible to muscle imbalances, requiring targeted ergonomic strategies and exercise routines for long-term health.Incorporating simple ergonomic habits into daily practice can reduce fatigue, minimize pain, and sustain clinical efficiency. To promote well-being and extend career longevity, dental professionals should:

1. Correct ergonomic flaws in the operatory setup
2. Consult therapists for persistent musculoskeletal issues
3. Address trigger points before starting strengthening exercises
4. Focus on stabilizing muscles, particularly in the shoulders and back
5. Stay consistent with preventive strategies[19]

By following these principles, clinicians can reduce physical strain, improve comfort, and maintain high-quality patient care throughout their careers.

REFERENCES

1. Murphy DC. Ergonomics and dentistry. NY State Dent J 1997 Aug-Sep;63(7):30-34. 1997;
2. Gupta G, Gupta A, Mohammed T, Bansal N. Ergonomics in Dentistry. Int J Clin Pediatr Dent. 2014 Apr;7(1):30–4.
3. Pîrvu C. The dentist's operating posture-ergonomic aspects. Vol. 7, Journal of Medicine and Life.
4. Murtomaa H. Work-related complaints of dentists and dental assistants. Int Arch Occup Environ Health. 1982 Aug;50(3):231–6.
5. Hill KB, Burke FJT, Brown J, Macdonald EB, Morris AJ, White DA, et al. Dental practitioners and ill health retirement: a qualitative investigation into the causes and effects. Br Dent J. 2010 Sep 11;209(5):E8–E8.
6. Soo SY, Ang WS, Chong CH, Tew IM, Yahya NA. Occupational ergonomics and related musculoskeletal disorders among dentists: A systematic review. Work. 2023 Feb 14;74(2):469–76.
7. Larbi HA, SuyetenkovDYe. Musculoskeletal dysfunction in dental practice. Russian Open Medical Journal. 2012 Jun 25;1(1):0105.
8. Hess JA, Hecker S, Weinstein M, Lunger M. A participatory ergonomics intervention to reduce risk factors for low-back disorders in concrete laborers. Appl Ergon. 2004 Sep;35(5):427–41.
9. Halkai R, Sulgante S, Sanadi RM, Ara SA, Zainab H, Kuriadom ST, et al. Work-related musculoskeletal disorders among dentists and their prevention through ergonomic interventions - A systematic review. Vol. 12, International Journal of Occupational Safety and Health. Occupational Health and Safety Society of Nepal; 2022. p. 125–39.
10. Chakraborty drs. occupational musculoskeletal pain in dentistry: a cross-sectional analysis of prevalence and contributing factors. Journal of Population Therapeutics & Clinical Pharmacology. 2023 Oct 15;3200–5.
11. Ohlendorf D, Erbe C, Nowak J, Hauck I, Hermanns I, Ditchen D, et al. Constrained posture in dentistry – a kinematic analysis of dentists. BMC MusculoskeletDisord. 2017 Dec 5;18(1):291.
12. Hussein A, Mando M, Radisauskas R. Work-Related Musculoskeletal Disorders among Dentists in the United Arab Emirates: A Cross-Sectional Study. Medicina (B Aires). 2022 Nov 28;58(12):1744.
13. Haghighi B. Association of Dental Practice as a Risk Factor in the Development of Carpal Tunnel Syndrome. Vol. 14, Journal of Dentistry Shiraz University of Medical Sciences. 2013.
14. Dong H, Barr A, Loomer P, Rempel D. The Effects of Finger Rest Positions on Hand Muscle Load and Pinch Force in Simulated Dental Hygiene Work. J Dent Educ. 2005 Apr;69(4):453–60.
15. Gupta A, Ankola A V., Hebbal M. Dental Ergonomics to Combat Musculoskeletal Disorders: A Review. International Journal of Occupational Safety and Ergonomics. 2013 Jan 8;19(4):561–71.
16. Rising DW, Bennett BC, Hursh K, Plesh O. Reports of body pain in a dental student population. The Journal

of the American Dental Association. 2005 Jan;136(1):81–6.
17. Ortiz Hugues JC. Ergonomics Applied to Dental Practice. 1st ed. Hanover Park, IL: Quintessence Publishing. 2023;
18. Deolia S, Dubey S, Chandak A, Patni T, Padmawar N, Sen S. Application of ergonomic postures during routine dental procedures in a private dental institute. Dentistry and Medical Research. 2018;6(2):41.
19. Carr GB, Murgel CAF. The Use of the Operating Microscope in Endodontics. Dent Clin North Am. 2010 Apr;54(2):191–214.
20. Chaikumarn M. Differences in Dentists' Working Postures When Adopting Proprioceptive Derivation vs. Conventional Concept. International Journal of Occupational Safety and Ergonomics. 2005 Jan 8;11(4):441–9.
21. Murrell KHE. Ergonomics: Man in his working environment. London: Chapman and Hall. 1965;
22. Hayes M, Cockrell D, Smith D. A systematic review of musculoskeletal disorders among dental professionals. Int J Dent Hyg. 2009 Aug 16;7(3):159–65.
23. Khan SA, Chew KY. Effect of working characteristics and taught ergonomics on the prevalence of musculoskeletal disorders amongst dental students [Internet]. 2013.
24. Dalai DR BDACGVSNBSS. Four Handed Dentistry: An Indispensable Part for Efficient Clinical Practice. Int J Adv Health Sci 2014;1(1):16–20. 2014;
25. Singh N JASNCARR. Application of Four-Handed Dentistry in Clinical Practice: A Review. Int J Dent Med Res 2014;1(1):8–13. 2014;
26. Aljanakh M, Shaikh S, Siddiqui AA, Al-Mansour M, Hassan SS. Prevalence of musculoskeletal disorders among dentists in the Ha'il Region of Saudi Arabia. Ann Saudi Med. 2015 Nov;35(6):456–61.