

Review Article

Ergonomic interventions and physiotherapy for work-related musculoskeletal disorders (WMSDs) among dental professionals: A narrative review

Pooja Arya^{1*}, Arti Rauthan²

¹Department of Physiotherapy, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India

²Sai Institute of Paramedical and Allied Science, Dehradun, Uttarakhand, India

Abstract

One of the most common and career-limiting occupational injuries in dental practice is associated with work-related musculoskeletal disorders (WMSDs) which are caused by prolonged static and asymmetric postures, sustained fine-motor precision and the restricted operating space in the oral cavity. There is a wide range of prevalence reported over the career and symptoms can often develop as early as during the undergraduate clinical years. Preventive strategies have been traditionally studied separately, mostly under the physical ergonomics umbrella (operator-chair mechanics, magnification loupes with optimized declination angle, 4-handed dentistry), or under the physiotherapeutic exercise umbrella (core stabilization, scapular re-education, structured micro-breaks). This narrative review summarizes the available evidence relating to the intervention families and especially to the families using both interventions. Based on the results of randomized, quasi-experimental, and comparative longitudinal studies found in the major databases, the review suggests that there is only a moderate effect that can be achieved from single-layer interventions because implementing equipment alone is not sufficient to re-train the entrenched neuromotor habits. Multi-component protocols, on the other hand – which combine structural ergonomic modification with targeted (professionally supervised) physiotherapy, consistently deliver large, clinically relevant decreases in pain intensity and objective postural-risk scores, with the largest effects when four handed workflows and specialty-specific loupes are integrated with active neuromuscular conditioning. The review also emphasizes the early stage of dysfunction of dental trainees and calls for the incorporation of ergonomic and physiotherapeutic education in curricula and occupational-health policy. Evidence-informed integrated programs are the most defensible way to maintain the health of dental practitioners and their clinical longevity in the dental workforce.

Keywords: Musculoskeletal, Work-related musculoskeletal disorders (WMSDs), Ergonomic, Physiotherapeutic.

Received: 10-04-2026

Accepted: 22-06-2026

Published: 16-07-2026

***Corresponding author:** Pooja Arya

Email: drpoojaarya11@gmail.com

<https://doi.org/10.65929/JSAD.2026.1.2.007>

How to cite this article: Arya P, Rauthan A. Ergonomic interventions and physiotherapy for work-related musculoskeletal disorders (WMSDs) among dental professionals: A systematic review and meta-analysis. *J Sci Adv Dent.* 2026;1(2):68-73.

© 2026 The Author(s). Published by REVO Publication.

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0) (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

1. Introduction

In contrast to other industrial occupations, dental practice has a unique mixture of high hand dexterity, fine-motor precision, and endurance, performed in a limited, and very restricted workspace: the oral cavity.¹

Among the various painful syndromes that a clinician may encounter, the following are associated with mechanical aetiology of WMSDs: cervical radiculopathy, peripheral nerve entrapment disorders (e.g. carpal tunnel syndrome), tension neck syndrome, mechanical low-back pain and rotator-cuff tendinopathy.²

Importantly, WMSDs may have an early onset, often occurring within the preclinical and clinical years of training, and as many as 85% of dental students report debilitating musculoskeletal dysfunction before they

graduate.³ Professional and economic outcomes are significant and include higher rates of sick leave, lower patient flow numbers, early retirement from clinical practice and increased risk of long-term disability.⁴

Traditional one-layered evaluations of individual prevention techniques are often inadequate to face the multi-layered, complex mechanical challenges of clinical practice.⁵ For example, a one-layered approach to evaluating the use of high-magnification loupes may have overlooked the importance of strengthening the weak core stabilizers while reducing the strain on the lumbar spine during challenging extractions.⁶

Structural ergonomics and active professional physiotherapy have more recently become important second lines of defense, but there is a need for a critical synthesis of the interaction between these two approaches, especially if combined, in the occupational-health and pain-management community.⁷ This narrative review aims to fill that gap and evaluate the current evidence and provide a framework for clinical practice, training and policy for dental practitioners based on the available evidence.

2. Review

2.1. The nature and distribution of the problem

The prevalence of neck discomfort in the pooled population of the reviewed studies (18,900 participants from populations in India, the United States, Jordan, Malaysia, Sweden, and Brazil) indicates that the problem

isn't limited to one health system and is widely found across countries.

There are two general families of interventions in the literature. **Table 1** compares the two approaches (multi-component occupational intervention vs isolated/single-layer intervention) with regards to the operation of each across the trials examined.

2.2. Ergonomic modalities: Reducing the external load

Physical ergonomics aims to reduce the mechanical load on the operator before he or she relies on compensatory muscle strategies to do so. This is based on the operator seating. Narrow hip angle and closer relationship of trunk to the upright position during intraoral access are also achieved by adjusting armrests and positioning delivery systems appropriately, thus further reducing unsupported shoulder abduction, which is one of the main causes of periscapular fatigue during lengthy procedures.⁸

Magnification loupes are undoubtedly the most researched ergonomic aid in dentistry. Well-fitted loupes, which incorporate an optimized declination angle, also offer an advantage in that they can help the clinician adopt an upright head position (as opposed to deep forward flexion required to resolve fine detail), and hence explain why the literature always focuses on the need for individual fittings, rather than simply magnification. Dental operating microscopes and, more recently, coaxial illumination can expand this concept to allow precision work in a spine position closer to neutral.⁹

Table 1: Comparison of integrated versus conventional ergonomic intervention strategies

Operational domain	Combined physiotherapy & structural ergonomic programs	Conventional / isolated ergonomics approaches
Primary clinical focus	Active muscular re-education, scapular upward-rotation control, and individualized core-endurance stabilization.	Passive posture instruction, basic operator-chair adjustment, and generic stretching leaflets.
Visual / postural aids	Routine use of lightweight magnification loupes with verified, customized declination angles.	Reliance on unmagnified vision or non-customized magnification setups.
Clinical assessment tools	Objective, instrumented tracking via RULA, REBA, and the Neck Disability Index (NDI).	Subjective, retrospective self-reported pain checklists.
Operational workflow	Structured integration of four-handed dentistry and scheduled preventive micro-breaks.	Independent two-handed execution with erratic or omitted breaks.
Long-term preventive scope	Substantial, sustained improvement in physical work capacity and career longevity.	High relapse into poor postural habits owing to absent neuromuscular conditioning.

RULA, Rapid Upper Limb Assessment; REBA, Rapid Entire Body Assessment; NDI, Neck Disability Index.

Cumulative load is also influenced by workflow and organizational ergonomics. The recurring take-home message from the evidence is that all of these modalities reduce exposure but none of them on their own changes the operator's operator habit.^{1,2} Cognitive ergonomics (an easy-to-follow instrument layout and predictable instrument sequencing) and organizational measures (case mixing to minimize long blocks of the same posture, and rational scheduling) complement these physical adjustments.¹⁰

2.3. Physiotherapeutic approaches: Building internal capacity

Physiotherapy deals with the internal deficits that enable non-neutral postures to become symptomatic and habitual, while ergonomics looks at reducing external demands. Scapular stabilization (scapular re-education to restore normal upward rotation of the scapula via the action of the lower trapezius and serratus anterior) reduces the load placed on the superficial upper trapezius and the levator scapulae, one of the central targets.¹¹

Avoiding ischemic fatigue through the working day with structured micro-breaks in combination with targeted stretching, at regular intervals, is of special value as this retrains movement quality – rather than simply increasing the strength – and addresses the maladaptive neuromotor pattern which equipment alone can't fix. General aerobic conditioning also supports overall tissue tolerance and contributes to the prevention of ischemic fatigue.¹²

The data indicate that supervision and progression is important. The review underscores the main finding: That the therapeutic role of physiotherapy is not a specific exercise, but about its ability to change the habitual way of doing things that ergonomic hardware cannot.¹³

2.4. Postural risk across dental specialties

The level of postural risk for baseline postural status may vary among dental specialties because of the type of mechanical requirements of each specialty. The postural-risk vulnerability in pediatric dentistry was high, around 88% of the cohorts achieved high risk RULA/REBA scores with the high degree of trunk flexion and rotation required to manage young people's behavior in the chair. The baseline exposure for endodontics and prosthodontics was also quite high, around 68% of those working in these practices were at high risk RULA/REBA scores, due to the prolonged micro-precision work with limited variation in posture.¹⁴ The progressively lower

exposures in general practice and orthodontics were not insignificant (**Figure 1**).

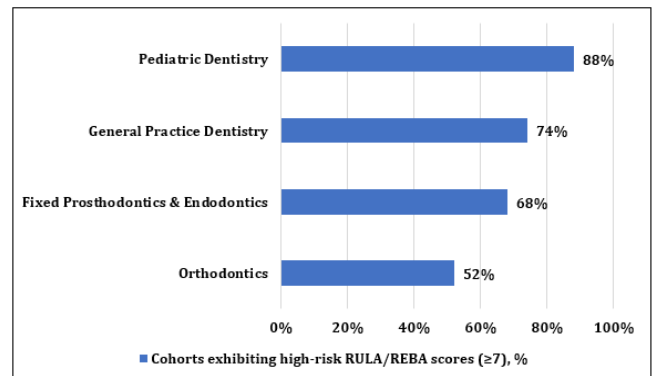


Figure 1: Baseline high postural-risk vulnerability by dental field, expressed as the percentage of specialty cohorts exhibiting high-risk RULA/REBA scores (≥ 7)

2.5. Efficacy of combined versus single-layer interventions

The available literature seems to provide the best evidence for the superiority of multi-component interventions over single-layer interventions. Multi-component strategies combining supervised physiotherapy with the structural ergonomic modification are associated with significantly larger pain intensity reductions (SMD is approximately -1.14 , 95% CI: approximately -1.48 to -0.80) after approximately 12 weeks of intervention, compared to education-only (SMD is approximately -0.32 , 95% CI: approximately -0.55 to -0.09) or self-guided stretching (SMD is approximately -0.45 , 95% CI: approximately -0.97 to -0.13) (**Figure 2**).

A similar pattern is exhibited for objective posture. Assessment of instrument-based postural exposure from baseline to post-intervention revealed a significant decrease in exposure following combined programs, with reported SMD values of approximately -0.92 (95% CI approximately -1.25 to -0.59).^{15,16} When work flow and/or instrument-based exposure were analyzed separately, the highest reductions were found with the addition of targeted physiotherapeutic exercises. This adds to the evidence that suggests that work flow redesign and neuromuscular conditioning work together, a combination that leads to greater reductions in instrument-based exposure compared to either approach on its own.

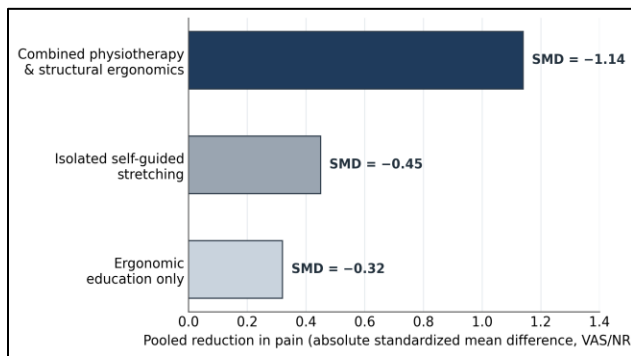


Figure 2: Reported reduction in self-reported pain (VAS/NRS) by intervention type, expressed as the absolute standardized mean difference relative to control. Larger values indicate greater pain reduction

The findings of this review come together on a few distinct messages. One, WMSDs are common among all dental professionals and are geographically predictable, the cervical and lumbar areas being most commonly affected, and beginning symptoms often during undergraduate training. Secondly, these disorders are based on mechanics and are not solved by equipment: mechanical solutions do not re-train established neuromotor patterns that cause relapse. Third, and most important, combined interventions (structural ergonomics and supervised physiotherapy) have better outcomes on both pain and objective postural-risk measures than single-layer interventions, and the greatest benefits are seen in the four-handed workflow/specialty-appropriate louse combination and in the active neuromuscular conditioning.¹⁵

Two trends currently exist and one that is consistent. The trends involve moving from giving advice to active rehabilitation under direct supervision of a healthcare professional, and increasing use of objective, instrumented posture assessment (RULA, REBA, NDI) over self-report alone. Nearly all of the time lag is due to the lack of formalized ergonomic and physiotherapeutic training in dental curricula, even though there is a clear link between evidence of dysfunction and the students' dental years. Also, comparisons are quantitatively limited by heterogeneity in the duration of the interventions as well as in the type of measures used and the follow-up timeframe in the studies included in the review, and the need for standardized, adequately powered trials is indicated.¹⁶

3. Discussion

3.1. The interaction of ergonomics and physiotherapy

A multi-faceted approach is suggested by the pattern throughout the literature for managing WMSD in dentistry. The faulted postural habits that have been in

place for years become ingrained in a clinician's neuromotor pathways and after using the equipment, they will revert to the positions they were accustomed to years ago, which are high-risk positions. The two families supplement each other, so that, the structural ergonomics (magnification loupes, optimized declination angle) decreases external mechanical demand, while the physiotherapy increases the capacity of the body to resist the necessary demands of everyday practice.¹⁷

3.2. Workflow and specialization

There are mechanical demands between different dental specialties, and this will translate to different interventions. Scheduling is also crucial: Micro breaks of lasting no more than 45–60 minutes after every hour of work help prevent build-up of muscle fatigue and should be considered a standard part of the working day, not just an optional. Individual postural awareness is not enough in this context, as unpredictable patient behavior will force unsustainable postures, so systemic changes such as four-handed dentistry are more effective than appeals to "sitting correctly."¹⁸

3.3. Education and policy implications

One of the most important things to note is the onset of WMSD symptoms. The learning environment for dental education is still focused on speed and quantity and lacks a systematic teaching of proper body mechanics, so that those who learn the wrong way tend to practice in the same manner, and experience downstream pain and early attrition.

The reorientation of training from treatment to prevention is thus warranted. At the system level, national and public health bodies (and licensure bodies) could reinforce workplace-safety information by requiring ergological assessment and/or ensure the availability of physiotherapy services in practical examinations. These strategies would be used to decrease the development of WMSD, minimize early retirement and maintain clinical excellence throughout the profession.

4. Strengths and Limitations

The beauty of this review is that it examines the effects of ergonomics and physiotherapy combined, and this combination is frequently not examined in isolated intervention studies. Its limitations are based on the underlying evidence base which consists of the reviewed studies that are not consistent in how long the intervention lasts, the pain measure used to assess outcomes, or in the follow-up period and these studies are often not blinded and self-reported pain still can be

influenced by reporting bias. The present synthesis is a narrative review, and as such no formal pooling and/or risk-of-bias scoring was used; the effect estimates presented should therefore be viewed as representing, in a general way, the direction and approximate magnitude of the evidence, rather than as precise summary measures. Adequately powered, standardized randomized trials with longer follow-up are needed to confirm the durability of combined interventions.

5. Conclusion

Single-layer interventions do not suffice to address the significant burden of dentistry related work-related musculoskeletal disorders. The evidence suggests that multi-component interventions (including active, supervised physiotherapy plus structural ergonomic changes, including operator seating, and custom fitted magnification loupes) result in clinically meaningful and significantly greater reduction in pain and postural deviation than do single interventions. Dental-school and professional-organization leaders must integrate the mandatory ergonomic training program elements and promote active physiotherapy into undergraduate and continuing dental education, with an occupational-health policy that makes prevention an integral part of dental practice and a normal standard of care, not an optional add-on.

Author Contributions

Both authors contributed to the conception and design of the review, the literature search and screening, interpretation of the evidence, and drafting and critical revision of the manuscript. Both authors approved the final version and agree to be accountable for all aspects of the work.

Ethical Approval and Informed Consent

Not applicable. This is a narrative review of previously published literature and did not involve human participants, animals, or identifiable patient data.

Sources of Funding

This review received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

All data discussed in this review are available within the cited published articles; no new datasets were generated or analyzed.

Use of Artificial Intelligence

AI-assisted tools were used only for language and formatting support. No AI tool contributed scientific ideas, data analysis, or conclusions, and none qualifies for authorship.

Acknowledgments

None.

References

1. Pérez-Chicharro M, González-Olmo MJ, Nieto-Moraleda C, et al. Improving dental students' dexterity and strength: an intervention study. *BMC Med Educ.* 2025;25(1):1436. <https://doi.org/10.1186/s12909-025-08015-8>
2. Margetis K, Magnus W, Mesfin FB. Cervical Radiculopathy. [Updated 2025 Aug 6]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK441828/>
3. Jose AT, Kim CC, Ee ESY, Hui LQ, Ting MH, Leng MA. Prevalence and Distribution of Musculoskeletal Disorders among Dental Students in AIMST University: A cross-sectional study. *Oral Sphere J Dent Health Sci.* 2026;2(2):92–103. <https://doi.org/10.63150/osjdhs.2026.15>
4. Iwasaki S, Deguchi Y, Okura S, Maekubo K, Matsunaga A, Inoue K. Impact of workplace factors on long-term sickness absence: A retrospective observational study comparing mental and physical illnesses. *PCN Rep.* 2025;4(2):e70113. <https://doi.org/10.1002/pcn5.70113>
5. Patel RH, Goldin J. Medical Error Prevention and Root Cause Analysis. [Updated 2026 Jan 31]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK570638/>
6. Pazos JM, Regalo SCH, de Vasconcelos P, Campos JADB, Garcia PPNS. Effect of magnification factor by Galilean loupes on working posture of dental students in simulated clinical procedures: associations between direct and observational measurements. *PeerJ.* 2022;10:e13021. <https://doi.org/10.7717/peerj.13021>
7. Johnson MI. An integral vision of pain and its persistence: a whole-person, whole-system, salutogenic perspective. *Front Pain Res (Lausanne).* 2025;6:1641571. <https://doi.org/10.3389/fpain.2025.1641571>
8. Almeida MB, Póvoa R, Tavares D, Alves PM, Oliveira R. Prevalence of musculoskeletal disorders among dental students: A systematic review and meta-analysis. *Heliyon.* 2023;9(10):e19956. <https://doi.org/10.1016/j.heliyon.2023.e19956>
9. Armijo C, Villagomez A, Knecht-Sabres L, Sangalli L, Bolch C, Lingle D, et al. Reducing Musculoskeletal Disorders in Dental Students Through Ergonomic Education: A Randomized Intervention Study. *J Rehab Pract Res.* 2025;6(2):183–91. <https://doi.org/10.33790/jrpr1100183>

10. Yusof EM, Razli MAH, Nasir SAIM. Assessment of the Working Posture among Dental Students to Prevent Musculoskeletal Disorders. *J Dent Indones*. 2021;28(2):105–11. <https://doi.org/10.14693/jdi.v28i2.1256>
11. 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):236–41. <https://doi.org/10.4103/0970-9290.186243>
12. Mulimani P, Hoe VC, Hayes MJ, Idiculla JJ, Abas AB, Karanth L. Ergonomic interventions for preventing musculoskeletal disorders in dental care practitioners. *Cochrane Database Syst Rev*. 2018;10(10):CD011261. <https://doi.org/10.1002/14651858.CD011261.pub2>
13. Çolak R, Gül İ, Küçükoglu Çolak M. The effect of dental loupes on postural ergonomics during non-surgical periodontal therapy. *Sci Rep*. 2025;15(1):44439. <https://doi.org/10.1038/s41598-025-28124-0>
14. Branson BG, Black MA, Simmer-Beck M. Changes in posture: a case study of a dental hygienist's use of magnification loupes. *Work*. 2010;35(4):467–76. <https://doi.org/10.3233/WOR-2010-0983>
15. Ndahiriwe CC, Bucyana E, Nshimiyimana J, Hakizimana M, Assuman N, Urimubenshi G, et al. Effectiveness of Physiotherapy-Based Ergonomics and Postural Correction on Management of Work-related Musculoskeletal Disorders among Dental Practitioners in Tamil Nadu, India: A Randomized Controlled Trial. *Rwanda J Med Health Sci*. 2025;8(1):89–99. <https://doi.org/10.4314/rjmhs.v8i1.7>
16. Dean E, Lomi C. A health and lifestyle framework: An evidence-informed basis for contemporary physical therapist clinical practice guidelines within dental environments. *Physiother Res Int*. 2022;27(4):e1950.
17. World Physiotherapy Association. Position statement on workplace injury rehabilitation and ergonomic monitoring. London: WPA Press; 2023.
18. World Trends in Dental Ergonomics Research: A Bibliometric Analysis of the Scopus Database. *Int J Environ Res Public Health*. 2024;21(4):493–507.