

Ergonomics and measures to prevent musculoskeletal disorders in dental practice. A scoping review

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Abstract

Dental practitioners are exposed to different occupational hazards during the course of their professional activity, such as physical, chemical, biological, ergonomic factors. The ergonomic hazards, caused by strained posture and prolonged repetitive movements, can induce musculoskeletal disorders. It occurs in 54–93% of dental professionals and involve the spine, shoulder and hand-wrist tract. Through a scoping review of international literature, we analyzed specific ergonomic risk factors and preventive measures of musculoskeletal disorders in professional dental activity. The presentation of this scoping review is in accordance with the PRISMA statement. The review included articles published in the last 22 years, from 2000 to 2022 on the major online databases (MEDLINE, SCOPUS, Cochrane Library). The search strategy used a combination of controlled vocabulary and free text terms based on the keywords.

Keywords- dentist, prevention, ergonomic, dentistry, musculoskeletal, neck pain, posture, ergonomics, work

Introduction

The word ergonomics “the science of work” is derived from the Greek nomenclature ergon and nomos. “Ergo,” means work and, “Nomos,” means natural laws or systems. Ergonomics, therefore, is an applied science concerned with designing products and procedures for maximum efficiency and safety.

The terms ergonomics and human factors are often used interchangeably or as a unit (e.g., human factors / ergonomics – HFE or EHF) a practice that is adopted by the IEA. The definition of ergonomics (or human factors) adopted by the IEA in 2000 is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance.(1) HFE takes into account physical, cognitive, sociotechnical, organizational, environmental and other relevant factors, as well as the complex interactions between the human and other humans, the environment, tools, products, equipment, and technology. (Figure. 1)

Every profession has specific occupational risks and hazards, which ultimately put ergonomics into play. Ergonomics focuses on changing work to meet individual needs rather than making accommodations for the environment as it is.

The dental profession necessitates highly skilled dental preparations that are controlled and precise. The dentist may experience pain as a result of the muscles being overworked for this purpose. Due to their limited access and restricted vision, which exposes them to occupational risks, dentists are believed to be the most prone to postural issues. It is crucial to prioritize ergonomic design in order to avoid repetitive strain injuries, which might eventually result in long-term incapacity. In order to boost productivity, ergonomic principles attempt to create a work environment that is largely safe and healthy for professionals.

Musculoskeletal diseases (MSDs) have become more common during the past few years. Researchers and healthcare practitioners have given MSDs a lot of attention because they are seen as a serious cause for concern.

Working in ergonomically sound settings is the most secure, effective, and simple method. The well-being and safety of patients, staff, and practitioners are improved by enhancing the ergonomic delivery of dental services and taking into consideration working conditions in dental offices. (2) Compared to the general population, dentists and dental hygienists are more susceptible to musculoskeletal diseases caused by their jobs. Pain and dysfunction of the neck, back, hands, and fingers are possible outcomes of these illnesses. An estimated 54% to 93% of dental professionals experience musculoskeletal injuries at work, with the spine (neck and back), shoulders, elbows, and hands being the most frequently injured areas. One study found that working with a bent neck causes neck pain in dental hygienists, and 72% of 94 experienced hygienists in the sample had neck issues (mean age: 46 years). (2)

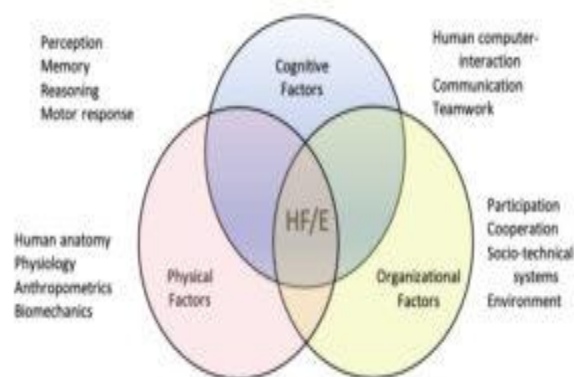


Figure.1. (Picture courtesy- International ergonomics association)

Aim- Purpose of this review is to evaluate the causes for musculoskeletal disorders among dental professionals and update the recommended corrective actions to prevent MSDs

Materials and Method

The presentation of this scoping review is in accordance with the PRISMA statement. The review included articles published in the last 22 years, from 2000 to 2022 on the major online databases (MEDLINE, SCOPUS, Cochrane Library). The search strategy used a combination of controlled vocabulary and free text terms based on the following keywords: dentist, prevention, ergonomic, dentistry, musculoskeletal, neck pain, posture, ergonomics, work and occupational. All search fields were considered. Additionally, we practiced a hand search on reference lists of the selected articles and reviews for a wider analysis. Two independent reviewers performed the search, read the titles and abstracts of the articles identified by the search strategy. Relevant reports were selected according to inclusion and exclusion criteria. Doubts or disagreements were solved through arbitration with a third researcher. Finally, the compatible full texts were independently assessed for definitive eligibility. Quality assessment Three different reviewers assessed the methodological quality of the selected studies with specific rating tools. We used INSA method “International Narrative Systematic Assessment” (La Torre, Backhaus & Mannocci, 2015) (3) to judge the quality of narrative reviews, the Newcastle Ottawa Scale to evaluate cross-sectional and cohort studies (Wells, Shea & O’Connel, 2009); while the JADAD scale was applied for randomized clinical trials (Jadad et al., 1996).

DISCUSSION

Role of ergonomics in dentistry

The Ergonomic Standard mandated by the Occupational Safety and Health Administration (OSHA) recommended that the most efficient and effective way to remedy “ergonomic hazards” causing musculoskeletal strain should be through engineering improvements in the workstation. In dentistry, bad working habits, repetitive tasks – such as scaling, root planning, and uncomfortable physical postures contribute greatly to musculoskeletal disorders, stress, and loss of productivity. Four-handed dentistry is ergonomically the most favorable way to provide dental services since it minimizes undesirable movements of the operating team and expedites the progress of most dental procedures (4). Available research supports the idea that ergonomic hazards can be managed or alleviated effectively using a multifaceted approach that includes preventive education, postural and positioning strategies, proper selection and use of ergonomic equipment and frequent breaks with stretching and postural strengthening techniques.

Risk factors for MSDs

Based on various studies conducted previously, the following are the variety of risk factors for musculoskeletal disorders (MSDs) that are encountered in dental practice (5).

Risk Factors for MSDs in Dental Procedures

Repetitive motions- Scaling, polishing Awkward postures Handling of objects with the back bent/twisted than straight

Static postures-Static neck, back & shoulders Forceful exertions in Tooth extraction

Duration- Grasping small instruments for prolonged periods

Contact stresses- Repeated contact with hard or sharp objects

Vibration-Prolonged use of vibrating hand tools

Other risk factors for MSDs are • Poorly designed equipment workstation eg-narrow working space • Improper work habits • Genetics • Medical conditions • Poor fitness level • Physical/mental stress • Lack of rest/recovery • Poor nutrition • Poor lighting • Environmental & psychosocial factors

Clinical features of musculoskeletal disorders (MSDs)

Signs and Symptoms

Decreased range of motion

Excessive fatigue in the shoulders & neck

Loss of normal sensation Tingling, burning sensation in arms

Decreased grip strength Weak grip, cramping of hands

Loss of normal movement Numbness in fingers & hands Loss of co-ordination.

Clumsiness & dropping of objects Hypersensitivity in hands & fingers

Mechanisms causing musculoskeletal disorders (MSDs) in dentistry

• Prolonged static postures (PSPs) • Muscle imbalances • Muscle ischemia & necrosis • Hypomobile joints • Spinal disc herniation & degeneration • Neck & shoulder injury • Carpal-tunnel syndrome (CTS) • Low back pain.

Goals of Ergonomics

• Reducing the risks of musculoskeletal disorders (MSDs).
• Improving worker safety. • Increasing worker comfort.
• Minimize worker fatigue. • Improving the quality of work.

Correct working postures: (Yamalick, 2007)

• Maintain straight position.

- Use an adjustable chair with lumbar, thoracic & arm support.
- Work close to your body.
- Minimize excessive wrist movements. • Avoid excessive finger movements. • Alternate work positions between sitting, standing & side of patient. • Adjust the height of your chair & the patient's chair to a comfortable level. • Consider horizontal patient positioning. • Check the placement of the adjustable light. • Check the temperature in the room. Patient positioning
Supine positioning of the patient in the chair is usually the most effective way to help to maintain neutral posture. The patient must lie comfortably without feeling pressure from the back.
Operator position

The clinician's access to the oral cavity should be truly unimpeded. The operator should be able to move freely the legs beneath the patient's head & headrest to avoid twisting or forward bending of the torso. 7 to 12:30 o' clock position is preferred for the right-handed operator, & 12:30 to 5 o' clock for the left-handed operator (6-9).

Magnification

Magnification allows to maintain a greater working distance, improve neck posture by helping the clinician prevent leaning forward towards the patient & provides clearer vision. Dental loupes, operating telescopes & microscopes are available for magnification systems. Using such equipments lets the dentist focus the eyes specifically on operating field. There is no need to flex the neck, upper spine, and lower back to improve visibility. (10,11)

Patient chair position

The goal is to promote patient comfort; maximize patient access.

Opt for: 1. Chair with a flat surface. 2. Stability. 3. Pivoting or drop-down arm rests 4. Headrest & neck support. 5. Wrist/forearm support. (12)

Operators stool

The goal is to promote mobility and patient access; accommodate different body sizes.

Look for: 1. Adjustable lumbar support. 2. Seat height adjustment. 3. Adjustable footrests. 4. Wrap around body support 5. Seamless upholstery

Recent trends & strategies in Ergonomics in Dentistry

- Four handed dentistry- Akesson et al. in their study noted that practice of four handed dentistry proved to be significant in reducing stress. When working in four-handed dentistry the dentist maintains a position around the operating field with limited hand, arm & body movement, and should best confine eye focus to the working field. The dental equipment & instruments

should be centred on the dental assistant promoting over-the head & over-the patient delivery system that allow better access during procedures. (13)

- Alternate between standing & sitting Standing allows reducing the pressure in the back. However, there are times when the dentist needs to sit. When sitting, the main part of the body weight is transferred to the seat. Alternating between the two positions lets one group of muscles rest, while the workload is shifted to another group of muscles. Alternating between standing & sitting can be an effective tool in preventing injuries.(14,15)

- Foot control dental unit- A foot control can be designed with a pedal on which the foot is placed either entirely, or partly. Placing the whole foot on the pedal causes an unfavourable load which results in the unequal position of the right & left foot which in turn causes an asymmetrical, harmful strain on pelvis & vertebral column. Therefore, it is necessary to place the heel on the floor so that it can support the foot, while the front part of the shoe is placed on the pedal.(16)

- Using matt surfaces- The surfaces of dental equipment & instruments have to be matt, to avoid fatiguing glittering effects on the eyes of the dentist. The colours used for dental equipment should be light for an optimal contrast to avoid more adaptation of the eyes than necessary & so prevent eye fatigue(17).

- Proper temperature- It is recommended that hands & fingers be kept above 25°C or 77°F to avoid detrimental effects on dexterity & grip strength. However there are no standards for temperatures. • Ambidexterity The majority of people prefer the use of their dominant hand when performing manual operations. While this can improve efficiency, it can also result in muscular overload of the dominant hand/arm. It is recommended that individuals attempt to alternate hands throughout the workday, whenever possible. However, this may not be practical.

- Micro breaks- The operator can take a break to prevent injury to the muscles & allow rest periods to replenish & nourish the stressed structures. A 30 second micro break may help the dentist to work effectively & efficiently.(18)

- Scheduling- Scheduling provides sufficient recovery time to avoid chronic muscular fatigue. Potential strategies include flexible scheduling systems, vary procedures within the same appointment, shorten patient's recall interval.(16)

- Stretching & exercises- Regular exercises, stretching, relaxation techniques (meditation, biofeedback & yoga) helps prevent injuries & combat stress thereby improving the quality of life. Body Strengthening Exercises (Valachi & Valachi, 2003) A. Stretching & strengthening the muscles that support the back & neck and those used in the forearm, wrist, and hand will help them remain strong & healthy. B. Periodic stretching throughout the workday. C. Resting hands frequently is believed to be one of the most important factors in preventing CTS. (19)

D. To relieve eyestrain caused by focusing intensely at one depth of vision for long periods, look up from the task & focus eyes at a distance for approximately 20 seconds. (20)

Conclusion

High productivity and the prevention of disease and injury are guaranteed by effective ergonomics application. It is essential to identify risk factors and put ergonomic methods into practice. A healthy musculoskeletal system can help dentists lead longer, healthier lives, operate in safer environments, and avoid MSDs.

References

- 1) IEA - International Ergonomics Association. What is Ergonomics? Available at <https://iea.cc/what-is-ergonomics/>
- 2) Morse T, Bruneau H, Michalak-Turcotte C, Sanders M, Warren N, Dussetschleger J, Diva U, Croteau M, Cherniack M. Musculoskeletal disorders of the neck and shoulder in dental hygienists and dental hygiene students. American Dental Hygienists' Association. 2007 Jan 1;81(1):10-10.
- 3) La Torre G, Backhaus I, Mannocci A. Rating for narrative reviews: concept and development of the International Narrative Systematic Assessment tool. Senses and Sciences. 2015 Jun 30;2(2).
- 4) Bridger, R. S. (2018). *Introduction to Human Factors and Ergonomics, 4th Edition*. Boca Raton, FL, USA. CRC Press.
- 5) Wilson, J. R. (2014). Fundamentals of systems of ergonomics/human factors. *Applied Ergonomics* (45), 5-13.
- 6) Yamalik N. Musculoskeletal disorders (MSDs) and dental practice Part 2. Risk factors for dentistry, magnitude of the problem, prevention, and dental ergonomics. International dental journal. 2007 Feb 1;57(1):45-54.
- 7) Munaga S, Rawtiya M, Khan S, Chitumalla R, Kubagiri S, Sajjan P. Assessment of knowledge, practices, and workplace condition related to ergonomics among dental students of Bhopal city - A questionnaire study
- 8) Harshid PL, Menhul MR, Mihir R, Piyanka P. Prevalence and associated factors of back pain among dentists in South Gujarat. Nat J Med Res 2012; 2: 229-31
- 9) Chang BJ. Ergonomic benefits of surgical telescope systems: selection guidelines. J Calif Dent Assoc 2002; 30: 161-69.
- 10) Valachi B, Valachi K. Mechanisms leading to musculoskeletal disorders in dentistry. J Am Dent Assoc 2003; 134: 1344-50.
- 11) Kierklo A, Kobus A, Jaworska M, Botuliński B. Work related musculoskeletal disorder among dentists – a questionnaire survey. Ann Agric Environ Med 2011; 18: 79-84.
- 12) Pope-Ford R, Jiang Z. Neck and shoulder muscle activation patterns among dentists during common dental procedures. Work 2015; 51: 391-99

- 13) Åkesson I. Occupational health risks in dentistry-Musculoskeletal disorders and neuropathy in relation to exposure to physical workload, vibrations and mercury. Lund University; 2000.
- 14) Sartorio F, Vercelli S, Ferriero G, d'Angelo F, Migliario M, Franchignoni M. Work-related musculoskeletal diseases in dental professionals. 1. Prevalence and risk factors. *Giornale italiano di medicina del lavoro ed ergonomia*. 2005 Apr 1;27(2):165-9.
- 15) Mehta A, Gupta M, Upadhyaya N. Status of occupational hazards and their prevention among dental professionals in Chandigarh, India: A comprehensive questionnaire survey. *Dental Research Journal*. 2013 Jul;10(4):446.
- 16) Pîrvu C, Pătraşcu I, Pîrvu D, Ionescu C. The dentist's operating posture—ergonomic aspects. *Journal of medicine and life*. 2014 Jun 6;7(2):177.
- 17) Williamson R. Prevention of musculoskeletal disorders. *Dentistry today*. 2015 Jun;34(6):10-1.
- 18) Hill KB, Burke FJ, 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;209:E8.
- 19) Valachi B, Valachi K. Mechanisms leading to musculoskeletal disorders in dentistry. *The Journal of the American Dental Association*. 2003 Oct 1;134(10):1344-50.
- 20) 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. *Dent Med Res* 2018;6:41-5