

A Comprehensive Review of Ergonomics in Dentistry: Current Practices, Challenges and Future Directions

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Abstract:- This paper presents a comprehensive examination of the role of ergonomics in pediatric dentistry, addressing its significance, current practices, and implications for dental education. The study delves into the awareness and compliance of dental students and professionals with ergonomic guidelines and evaluates the impact of ergonomics on musculoskeletal health. Additionally, it discusses the state of ergonomics education in dental schools and its potential implications for the future. The findings underscore the critical need for heightened awareness and training in ergonomics within the dental profession, aiming to improve both patient care and practitioner well-being. As pediatric dentistry evolves, embracing ergonomic principles becomes paramount for the holistic betterment of dental care.

Keywords:- Ergonomics, Pediatric Dentistry, Work Related Muscle Disorders (WRMDs), Dental Education, Work Postures, Dental Chair.

I. INTRODUCTION

Ergonomics can be defined as ‘an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely’. Dental professionals face various work-related risks, like physical, chemical, biochemical, and ergonomic hazards, often leading to musculoskeletal disabilities. ^[1]

Dentists, due to prolonged static postures and high muscle activity, face significant risk of developing WRMDs (Work Related Muscle Disorders). ^[2] Recent reviews show 54–93% of dental professionals suffer from WRMDs, primarily affecting neck, shoulders, upper extremities, and lower back. ^[3] The 2018 survey by the American Dental Association (ADA) found that a significant number of active dentists, 7,475 in total, are susceptible to musculoskeletal issues, primarily related to poor ergonomics impacting their neck and lower back. A high proportion, two-thirds of the participants, experienced varying degrees of neck and back pain, with almost half describing the pain as moderate to severe. ^[4]

By enhancing awareness of work postures, modifying workstations to encourage neutral positions, evaluating instrument impact on upper extremity pain, and adopting healthy work practices, one can mitigate these issues associated with the physical toll dental work takes on the practitioner's body. ^[5]

Beyond mere awareness, implementing practical solutions such as ergonomic workstations that promote neutral postures, assessing the impact of instruments on upper extremity pain, and advocating for healthy work practices can significantly contribute to mitigating the physical toll of dental work. This approach not only addresses the immediate concerns highlighted in the survey but also fosters a sustainable and ergonomic environment, ultimately enhancing the overall health and longevity of dental professionals in their demanding field.

II. ERGONOMICS IN DENTISTRY

Ergonomics in dentistry involves designing workspaces and equipment to optimize the comfort and efficiency of dental professionals while reducing the risk of musculoskeletal injuries. Proper ergonomic design is crucial to ensure dentists, dental hygienists, and assistants can work comfortably and safely during procedures. It includes considerations like chair and equipment placement, instrument design, and body posture to minimize strain and discomfort during dental work.

Musculoskeletal disorders are increasingly prevalent in dental practice worldwide. Studies highlight back, neck, and shoulder pain as significant issues for dentists. Reported pain percentages from various studies are as follows: Shugars et al. (1987) - 60%, Runderantz et al. (1990) - 72%, Auguston and Morken (1996) - 81%, Finsen et al. (1997) - 65%, and Chowanadisai et al. (2000) - 78%. The prevalence of general musculoskeletal pain ranges from 64-93%. ^[6] A study by D.J. Veeresh et al. revealed that 34.71% of dentists experience at least one musculoskeletal pain, with a higher frequency in the neck (71%). ^[7] Another study by Mohamed Faisal and Lawrence Mathias noted prosthodontists having a higher ratio of musculoskeletal symptoms in the lower back region. ^[8]

Back pain is often caused by overstrained and awkward postures, while neck and shoulder disorders result from repetitiveness. Psychosocial stressors further contribute to complaints in these areas. These issues can be mitigated through heightened awareness of work postures, workstation redesign for neutral positions, analysing instrument impact on upper extremity pain, and adopting healthy work practices to alleviate the physical strain of dental work on practitioners (Jabbar, 2008).^[9]

The Occupational Safety and Health Administration (OSHA) mandates an Ergonomic Standard. This standard recommends that the most efficient and effective approach to address "ergonomic hazards" leading to musculoskeletal strain is through engineering improvements in the workstation.^[10]

III. DENTAL STUDENT'S AWARENESS OF ERGONOMICS

A Cross-sectional Survey by Jadhav HC et al found that students and dental professionals knew more about ergonomics theoretically than they did about how to apply it in practice settings. To lower the risk of musculoskeletal problems among aspiring dentists, ergonomic principles must be included into dental education and daily living. Gaining understanding about ergonomics will be beneficial for all dentists in their clinical activities.^[11]

In a cross-sectional study conducted by Ramesh N et al on Knowledge, Awareness, and Practices about Ergonomics among Dental Post-graduate Students acknowledged that working with poor posture can have long-term effects. Therefore, it is important to adhere to appropriate postural parameters. It was discovered in our research that a large number of postgraduate students were eager to learn about the most recent ergonomic posture via different platforms. A large number of them suggested live demonstrations, workshops, and training to reduce work fatigue. A small percentage of respondents also stated that ergonomics ought to be covered in undergraduate and graduate courses as well as be a daily curriculum. The study concluded that different dental institutes have an appropriate degree of ergonomic knowledge. Postgraduates ought to strive for the appropriate implementation of ergonomic posture in clinics and should inspire others to practice dentistry with ease.^[12]

A study by Anu V et al on Insights about Dental Ergonomics among Dental Students, most of the students were aware of dental ergonomics and musculoskeletal diseases, while relatively few of them actually practiced it. The necessity of including dental ergonomics into the academic curriculum was suggested by this study.^[13]

According to study by Cervera-Espert J., et al on dental students of the University of Valencia concluded that 96% of dental students stated to understand ergonomics, only 58% of them could demonstrate the proper working posture for

various procedures, and only 29% of them could sit in the right position.^[14]

IV. EDUCATION ON ERGONOMICS IN DENTAL SCHOOLS

While the students seemed to have a reasonable understanding of ergonomics, there was a deficiency in its practical application. The prevalence of shoulder, neck, and back pain rose as dental school started. It is imperative that undergraduate dental students' ergonomic training be re-evaluated and given more attention during the undergraduate training program.^[15]

Dentists can avoid musculoskeletal disorders in their students by incorporating ergonomics into their preclinical training and then reinforcing it during clinical practice. To customize ergonomics educational programs in dental curriculum and identify areas of success as well as those requiring improvement, curriculum revision must be supported by epidemiologic studies, faculty development, and timely evaluation.^[16]

In order to provide ergonomic principles both theoretically and practically, dental health care personnel's ergonomic education needs to be concentrated in all educational institutions and continuing dental health programs. It should also be a part of the curriculum.^[17]

Though theoretical knowledge might have been acceptable, all of the studies found that there were concerns about how it was put into practice. The self-reported and theoretical knowledge scores were found to be comparable. The students understood this, even though the average student's knowledge of ergonomics was only moderate. There was no doubt that the students had received some instruction, probably in the form of lectures, since they did possess some knowledge of ergonomics. These basic ideas may have been overlooked as a result of the knowledge being underemphasized, which would account for the comparatively low average scores. The students' theoretical understanding as well as their practical application of that knowledge were also clearly at odds with one another.^[15]

V. IMPACT ON MUSCULOSKELETAL HEALTH

Musculoskeletal disorders (MSDs) are a prevalent concern within the dental profession, encompassing injuries and disorders affecting muscles, nerves, tendons, ligaments, joint cartilage, and spinal discs. Dentists face a substantial risk of developing these work-related problems, with the incidence of neck and back pain significantly higher in this group than in the general population. This elevated risk can be attributed to the extreme postures dentists often assume during their clinical work, which place a considerable strain on their musculoskeletal system.^[18]

Various studies have consistently reported data related to the incidence and distribution of musculoskeletal pain among dentists. Notably, the neck region is the most commonly affected site, with over 85% of dentists experiencing discomfort or pain in this area. This alarming prevalence underscores the urgency of addressing musculoskeletal issues in the dental profession^[19,20,21,22,23].

➤ *Risk Factors for Musculoskeletal Problems among Dentists*

Ergonomics experts in dentistry have identified several risk factors contributing to musculoskeletal problems among dentists. These factors encompass maintaining a seated posture while accessing the oral cavity, frequent bending when treating patients, prolonged muscle contractions, and the repetitive motions inherent to dental work^[4]. Moreover, a study investigating the effects of ergonomics on cervical neck pain highlighted the importance of technique, ergonomic conditions, and the sustained maintenance of static body positions in determining the degree of neck region strain^[24].

A comprehensive review of thousands of studies emphasizes that static postures are a leading cause of musculoskeletal disorders in the dental profession. Dentists frequently find themselves in awkward postures, such as extreme forward-head and neck flexion, trunk inclination and rotation to one side, raised shoulders, increased curvature of the thoracic vertebral column, and improper positioning of the lower limbs, with a thigh-leg angle of less than 90°. Given these challenges, it is imperative to utilize modern workstations equipped with appropriate ergonomic support to mitigate the risk of musculoskeletal issues among dentists. Additionally, existing literature underscores the importance of physical activity and maintaining a neutral, balanced posture as effective preventive measures to alleviate the burden of musculoskeletal disorders in dentistry^[3].

Musculoskeletal disorders (MSDs) can encompass a range of issues, and in the context of dentistry, dentists may encounter the following types of MSDs:

➤ *Back Problems:*

- **Lower Back Pain:** Common, with various contributing factors such as lumbar flexion and rotation, hip inflexibility, and weak lumbar stabilizing muscles^[25,26]
- **Upper Back Pain:** Less common but often related to postural and scapular muscle issues.^[26]

➤ *Hand and Wrist Problems:*

These can result from repetitive motions, awkward hand positions, prolonged work without breaks, and mechanical stresses. Common conditions include tendinitis, DeQuervain's disease, trigger finger, carpal tunnel syndrome, and Guyon's syndrome.

Signs of MSDs may include decreased range of motion, loss of normal sensation, decreased grip strength, loss of normal movement, and loss of coordination.^[27]

Symptoms of MSDs can manifest as excessive fatigue in the shoulders and neck, tingling, burning, or pain in the arms, weak grip, hand cramping, numbness in fingers and hands, clumsiness, and hypersensitivity in hands and fingers.^[27] Dentists should be aware of these potential issues and take steps to prevent and manage them to ensure their well-being while practicing.

➤ *Strengthening exercises for the body, as discussed by Valachi and Valachi in 2003, encompass various strategies:*

- Engage in muscle stretching and strengthening routines that target the back, neck, forearm, wrist, and hand muscles to maintain their strength and promote overall health.
- Incorporate periodic stretching sessions into your workday to prevent muscle fatigue.
- Take regular breaks to rest your hands, which is crucial in preventing Carpal Tunnel Syndrome (CTS).
- Alleviate eyestrain resulting from prolonged focus on a single depth of vision by periodically shifting your gaze to a distant point for around 20 seconds.
- Perform a gentle head and upper body exercise by bending forward, allowing your head and arms to lower between your knees, holding this position briefly, and then slowly rising by engaging your abdominal muscles and lifting your head last.
- Address neck stiffness by gently rotating your head from side to side and forward and backward, making sure not to push beyond your comfortable range of motion.^[28]

VI. HOLISTIC ERGONOMICS FOR FUTURE DENTAL PROFESSIONALS

Over the course of their career, dentists may labour in strained and twisted positions for up to 60,000 hours, which can lead to musculoskeletal issues^[26]. Although good posture is not ideal for the dental field, it is feasible to rectify the bad postural habits that may be the source of this tension and suffering with training and practise^[29]. Early in a dental professional's career—even throughout their academic training—symptoms of WRMSDs may manifest. These kinds of aches and pains typically develop gradually, go unnoticed, and become chronic, permanent, and challenging to treat^[30,31]. The application of dental ergonomics concepts has been demonstrated in numerous prior research to reduce or eradicate symptoms linked to WRMSDs in dentists^[32]. Consequently, based on the following adage, "prevention is better than cure," dental students should receive more instruction in the fundamentals of dental ergonomics prior to beginning their practical clinical training. In addition, in order to reduce the prevalence of WRMDs, dental students must be well-versed in the fundamentals of WRMD-related physiology and biomechanics. Because of this, treating WRMDs also

requires adhering to dental ergonomics and biomechanical concepts. It is also advised to condition the muscles through the use of targeted workouts and stretches in order to prepare them for the demands of clinical dentistry work [33]. Since all other disciplines are learned, dental ergonomics and WRMDs are actually the only ones that have a direct bearing on the health of dental professionals or students to treat patients.

You'll discover that you're less tired at the end of the day, that you're in less pain, and that you're able to give your patients the high-quality care that both you and they require. The following six wellness tips can enable dentists to work longer and more comfortably while experiencing less fatigue.

- First and foremost, address the operator's ergonomic issues.
- For musculoskeletal diseases, physical therapists and neuromuscular therapists should be consulted.
- Prior to beginning any strengthening exercises, major trigger points should be addressed.
- Develop the strength of particular stabilising muscles (back, shoulder, etc.).
- Exercise patience, but above all, make a commitment to a consistent preventative regimen.
- Throughout the workday, it's crucial to stretch while seated to avoid microtrauma and muscular imbalances [34].

VII. OPTIMIZING POSTURE FOR DENTAL PROFESSIONALS: ACHIEVING A BALANCED AND ERGONOMIC POSITION

In ergonomics, posture relates to the positions of the various body parts and the reports that are created between them to enable the performance of specific tasks. For dentists, the balanced or neutral posture outlined in "ISO Standard 11226 Ergonomics – Evaluations of Static Operating Postures" is advised. The following guidelines comprise "balanced posture" as it relates to dentists:

- Equivalent weight bearing on the ischial tuberosity of the pelvis while seated symmetrically.
- A straight back; do not form a "C" shape with your back.
- A maximum of 20° forward inclination of the trunk; a larger forward inclination results in less trunk rotation and tilting aside.
- A head tilt forward that is up to 20–25 degrees from the trunk. (Optimally, an angle of no more than twenty degrees).
- The arms are positioned across the body, forward-facing within a 10° angle, and the forearms are lifted to a 25° angle from the horizontal.
- A 105–110° or greater angle between the thighs and calves.
- A maximum 45° gap between the thighs to avoid the hip joint becoming rigidly fixed.
- The calves are positioned somewhat posteriorly or perpendicular to the floor.
- In the same plane as the calves, feet are put on the floor and pointed forward. The posture is balanced when the feet

are positioned symmetrically beneath the operator's hands [35,36].

- The most effective sitting position to lower the incidence of low back pain is to have a modest anterior pelvic tilt and a slight lumbar lordosis [37].
- McKenzie exercise methodology and therapeutic exercises [4,24].
- Consistently taking breaks and stretching during working hours to minimise and avoid musculoskeletal injuries in dentists, particularly in the neck and shoulder areas [38].
- Training the deep cervical flexors may lessen neck discomfort and impairment and enhance forward head posture [39].

VIII. PEDIATRIC CHAIR vs CONVENTIONAL CHAIR

A questionnaire survey was conducted in 2015 by Barjatya, et al. where responses were collected from 377 pedodontics. This resulted in – 79% of pedodontics utilized a paediatric dental chair, while 21% lacked experience due to its unavailability. Within this group, 89% had a favourable view of the chair's use, while 11% were reluctant to work with it.

Overall, 93% of pediatric dentists indicated the necessity of a spittoon when treating child patients, and 85% mentioned its easy accessibility on a paediatric dental chair. Our findings demonstrate the preference of most paediatric dentists for using a paediatric dental chair in their clinics. However, over 40% expressed reservations about its cost-effectiveness. When asked about modifying a traditional dental chair to meet paediatric standards, 55% responded affirmatively, while 27% were opposed.

The main problems identified during the study were ergonomics and usability issues. It's crucial to emphasize the significance of a well-designed patient chair and dental delivery systems for the comfort and health of the dentist. [40]

IX. CONCLUSION

The field of ergonomics has significantly embraced dentistry. This review shows that dental students generally lack sufficient basic knowledge of dental ergonomics. There should be a targeted approach to teach dental students the principles of dental ergonomics before they begin their clinical activities, as multiple prior studies have demonstrated that inadequate adherence to these principles can result in WRMSDs among dental professionals. A well-thought-out future vision is necessary for the continued advancement of dental ergonomics. Appropriate ergonomics, coupled with regular exercise, relaxation methods (such as yoga, meditation, and biofeedback), and a healthy diet, helps us fight stress and preserve our productive energy, which in turn makes us more comfortable, enhances our quality of life, and eventually results in longer careers.

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