Policy Article

Importance of Teaching Ergonomics in Dental School Education

ABSTRACT

Aims: The aim of this study was to present the prevalence of musculoskeletal symptoms in dental students and their ergonomics knowledge, the challenges of the implementation of ergonomics in dental school curriculum, and the teaching of ergonomics in dental courses.
Methodology: This manuscript was supported by scientific evidence found in the literature obtained from Science Direct, Scientific Electronic Library Online (SCIELO), and National Library of Medicine (MEDLINE) databases, as well as the authors' experience in ergonomics education and research studies.
Results: Most dental students have reported pain in their neck, lower back, and shoulders. Although students have experienced musculoskeletal symptoms, they have a limited perception of work risk factors due to the lack of ergonomics education while in dental school. The challenges of its incorporation could be addressed through curricular revisions.
Conclusion: Implementation of ergonomics in the dental curriculum at the beginning of preclinical training and its reinforcement later in clinical practice can prevent musculoskeletal disorders in dental students. Curricular revision needs to be accompanied by epidemiologic studies, faculty development, and timely evaluation in order to customize ergonomics educational programs in dental curriculum and identify areas of success as well as those needing improvement.
Note: Review paper may have different types of subsections.

Keywords: Ergonomics, curriculum, dental education, undergraduate students, musculoskeletal disorders

1. INTRODUCTION

Dentistry is a profession that requires high visual demands, concentration, accuracy, and application of clinical skills in a restricted operative field [1,2]. Such requirements may constitute an obstacle to the maintenance of the occupational health of dentists, who are susceptible to musculoskeletal and joint overload due to the long period of static work since their first years of preclinical training [3,4].

In this context, ergonomics applied to dentistry plays an important role to reduce physical stress and prevent injuries related to clinical practice, providing a suitable, safe, and comfortable environment for the professional, who will be able to achieve high productivity while maintaining their quality of life [5]. Through educational measures, ergonomics promotes awareness regarding the risks related to the adoption of inappropriate work postures, as well as proposes solutions for preventing musculoskeletal disorders [6].

Ergonomic recommendations regarding the correct positioning of the patient and the dental equipment, as well as the dentist's working posture, should be taught in the dental curriculum [7]. Thus, the development of good postural habits, which leads to the maintenance of the ergonomic work position during clinical care, is facilitated [7]. Ideally the teaching of ergonomics should be included in the curriculum of dental schools from the beginning of pre-clinical training during the development of hand skills in simulated practice and should be reinforced during patient care [8, 9]. Early awareness is of great importance for the control and internalization of knowledge regarding the adoption of favorable ergonomic postures [3,5,9]. According to Duong et al. 2010 [10], it is easier to apply knowledge acquired correctly in early stages rather than relearn concepts and change habits that were practiced incorrectly.

Although several studies have evaluated the effectiveness of ergonomics teaching techniques and the knowledge acquired by dental students [5,7,8,11,12], the actual teaching of ergonomics and its implementation in the curriculum of dental schools has rarely been presented in the literature.

Dental schools have focused on providing students with extensive clinical experience in all dental specialties but have neglected training these professionals in maintaining their occupational health [3,8,13]. It is extremely necessary to improve the teaching of ergonomics in dental schools and incorporate its principles in the curriculum in order to increase students' knowledge and prevent musculoskeletal disorders [5].

Despite the importance and contribution of ergonomics in the dentists' professional lives, the teaching of ergonomics is deficient in dental schools. This can compromise the level of awareness, as well as the adoption of ergonomic requirements [7]. The clinical performance and patients' comfort have been prioritized, which can affect the professionals' health in both the short and long term [12].

Therefore, ergonomic principles are essential in daily practice both during the students' training and their professional lives. The early introduction and continual reinforcement of ergonomics training is very

important [11]. The aim of this study was to present the prevalence of musculoskeletal symptoms in dental students and their ergonomics knowledge, the challenges of the implementation of ergonomics in dental school curriculum, and the teaching of ergonomics in dental courses.

2. METHODOLOGY

This paper was supported by scientific evidence found in the literature obtained from Science Direct, Scientific Electronic Library Online (SCIELO), and National Library of Medicine (MEDLINE) databases considering the period from 1991 to 2022, as well as the authors' experience in ergonomics education and research studies.

The search was focused on dental ergonomics and musculoskeletal symptoms in dental students.

3. RESULTS AND DISCUSSION

The results obtained from the literature review are presented in the following topics.

A) Prevalence of musculoskeletal symptoms in dental students and their ergonomics knowledge

Work-related musculoskeletal disorders are one of the main occupational health hazards affecting dental students [14]. Early signs of musculoskeletal disorders have been seen in dental students during their years of training [14]. Botta et al. 2018 [15] observed that most students from the Stony Brook School of Dental Medicine reported pain in their neck (73.79%), lower back (62.06%), and shoulders (53.10%) in the previous 12 months regardless of their academic level. Rising et al. 2005 [16] revealed that more than 70% of dental students experienced neck, shoulder, and lower back pain as early as the third year of their dental training. The high prevalence of symptoms mainly in the upper body is related to muscle fatigue due to unusual static postures during patient care which compress the blood vessels and decrease the oxygen supply [17,18]. The lower back pain may be the result of muscle imbalance caused by repeated unilateral twists, inadequate lumbar support for long work periods, or non-ergonomic dental stool design [15].

A significant difference in the prevalence of discomfort and musculoskeletal symptoms was observed between dental students in their clinical and non-clinical years [14]. This was attributed to the difference in the nature of work, practicing pattern, and working hours between pre-clinical and clinical dental education [14].

Dental students have a limited perception of work risk factors even though they experience musculoskeletal symptoms [15]. The lower the students' academic level, the greater their perception of these risk factors [15]. Over time, students engage in clinical activities focusing on providing outstanding treatment to their patients instead of giving appropriate attention to the risk factors present in their work environment [15]. Due to the multifaceted complexities of patient care, dental students tend to overlook the hazards and consequences of poor posture [13].

The reporting of musculoskeletal symptoms by dental students in the early years of their dental program suggests that ergonomics should be covered and taught as part of the dental curriculum in order to reduce risks of musculoskeletal disorders in the future [14]. However, the teaching of ergonomics in dental schools is not a common practice worldwide [8]. Most students from Malaysian dental schools indicated that ergonomics had not been taught in their curriculum [14]. Ninety-two percent reported minimum participation in workshops related to ergonomics in dentistry and 77% were unfamiliar with treatment and remedies available for musculoskeletal disorders [14]. El-sallamy et al. 2018 [8] reported that only 48.9% of Egyptian dental students had fair ergonomics knowledge and only 5% applied the knowledge in practice.

Therefore, the lack of ergonomics knowledge may have contributed to students' limited perception of risk factors [15]. Strategies to reduce the effects of occupational hazards should be developed and implemented to ensure the well-being of dental students [19]. Training students to identify and recognize factors in their work environment that may contribute to musculoskeletal symptoms is an important educational objective to be considered [19].

B) Challenges of the implementation of ergonomics in dental school curriculum

Implementation of preventive educational programs can help to enhance students' knowledge about ergonomics and allow early detection of their musculoskeletal disorders [15]. Theory and practice of ergonomics should be incorporated into the dental school curriculum. More emphasis should be put on the acquisition of ergonomics knowledge during the early years of dental programs in order to allow students to apply their theoretical ergonomics knowledge to their clinical practice and help prevent deleterious habit formation [14].

Although several studies have supported the teaching of ergonomics in the dental curriculum [16,19,20], its implementation at early stages may be difficult due to three main factors: the lack of faculty expertise and calibration,

limited classroom time, and the lack of a four-handed dentistry educational program.

Lack of faculty feedback and students' deficient experience have made it difficult to emphasize the importance of teaching the principles of ergonomic work posture [11]. Faculty feedback could be compromised by their limited ergonomics knowledge and lack of expertise in the area. Most dental clinicians do not have a high level of ergonomics education and do not apply its principles during patient care. However, they have recognized as high priority that training of ergonomics and professional health is necessary [21]. Partido 2017 [13] described the importance of offering ergonomics training programs to faculty in order to provide education and standardize the teaching of ergonomics in dental schools. The photography-assisted ergonomics calibration program used in his study incorporated features to improve accessibility and optimize the quality of the training. The opportunity to reconcile different opinions resulted in improved agreement among the participants [13].

Attention is needed to the development of ergonomic calibration training programs for preclinical and clinical faculty members [13]. The outcome of effective calibration training is to promote the ability of faculty to consistently use specific criteria-based standards to evaluate student performance and to consistently apply those standards with students. Evaluations made by calibrated faculty promote student satisfaction, performance, and learning outcomes [13].

The teaching of ergonomics is challenging due to limited time available for its implementation in preclinical and clinical courses. In order to solve this issue, new teaching approaches that require reduced classroom time should be taken in consideration to facilitate the inclusion of ergonomics in the curriculum. The association of digital initiatives with independent studies seems to be an innovative alternative for the teaching of ergonomics in dental courses. Stony Brook School of Dental Medicine implemented a digital ergonomics app as a teaching resource in the operative dentistry course as a self-study in 2017. Research studies are in progress to evaluate its effect on dental students' theoretical and practical knowledge in both the short and long term.

Four-handed dentistry is an ergonomic chairside work arrangement performed by a well-trained dental team in an organized manner [14]. The overall concept provides more efficient delivery of dental care and increased productivity [14]. The use of four-handed dentistry is significantly associated with lower prevalence of elbow and forearm discomfort [14]. Although four-handed dentistry reduces the musculoskeletal symptoms and enhances patient care, it is not incorporated in all dental education programs. This can

be explained by the lack of dental assistant programs available in some dental schools or resistance in the implementation of this ergonomic chairside work arrangement with dental students. This resistance is usually due to educational culture or misunderstanding that students would be more productive and have better hand skills if they do not work in pairs.

All challenges of implementation of ergonomics in dental education can easily be addressed through curricular revisions. The feedback and support of dental students is essential for this process. According to El-Sallamy et al. 2018 [8], 84.8% of students had a positive attitude towards studying ergonomics which demonstrates their interest to increase their knowledge and involve ergonomics in their routine dental practice.

Epidemiologic research studies are necessary to identify the most appropriate ergonomics education program for students. Educational and motivational programs should be conducted with the joint participation of ergonomics professors and those from various dental specialties to integrate the teaching of ergonomics to basic, social, and clinical science. The design of frequent learning opportunities where faculty groups with various expertise come together to share information and facilitate student learning should be considered [22]. It is essential to motivate students and faculty continually to accept and further engage in curricular reform [22].

C) Teaching of ergonomics in dental courses

Ergonomics was incorporated into the curriculum of Brazilian dental courses in 1965 at School of Dentistry of Araraquara, in 1966 at Bauru School of Dentistry, in 1967 at Ribeirão Preto and São José dos Campos Schools of Dentistry, and in 1972 at Lins Dental School [23]. In 1979, the Brazilian Study Group of Professional Dental Orientation decided to standardize the name of the course that addressed this subject in all Brazilian dental schools, and therefore the name Professional Orientation was adopted [23]. Despite its importance for dental practice, its approach was generally related to the teaching of theoretical concepts [24].

At School of Dentistry of Araraquara, the main focus of the Professional Orientation course was initially the teaching of administrative principles with emphasis on professional success. Ergonomics was only one of the topics addressed in this course. Professor Fábio de Angelis Porto, who was responsible for introducing this course in School of Dentistry of Araraquara, proposed integrating the teaching of ergonomics in the Comprehensive Care Clinic, which enabled students to put into practice concepts related to ergonomic posture, rationalization, and four-handed dentistry [25]. In order to do so, it was established that the students should work in pairs with each individual alternately playing the role of operator and

dental assistant, so that both could practice the four-handed work in different ways. To date, School of Dentistry of Araraquara follows this concept of working in pairs in all clinical courses of the dental curriculum.

For nearly four decades, the teaching of ergonomics at School of Dentistry of Araraquara occurred in the Professional Orientation course, given during the second and fourth years of the students' education, with limited clinical practice. However, since 2000 the Research Group on Ergonomics in Dentistry and Occupational Health from this school has begun a series of research studies to observe students' postural behavior. Early research has shown that although students were taught ergonomics, they still had many postural deficiencies [26,27] and were considered at high risk of developing musculoskeletal disorders, both in their pre-clinical [20] and clinical training [28]. Garcia et al. 2013 [19] evaluated the students' perception of risk factors related to the musculoskeletal symptoms in their work/study environment and found that work posture was the predominant factor. The data obtained in these first studies was important to show the need to review the teaching of ergonomics at School of Dentistry of Araraquara.

Based upon this review, changes in the curricular structure were proposed and implemented, with modifications not only in the course's name, but also in its form of presentation. The name adopted was Ergonomics in Dentistry, with an approach focused on the execution of dental procedures in order to maintain the students' quality of life [20]. In this new structure the theoretical part is given in the second year of the course, with weekly classes (workload of 15 hours) addressing the following topics: concepts of productivity and ergonomics applied to dentistry, requirements for ergonomic posture in dentistry, organization of trays and dental charts to perform clinical and laboratory procedures, occupational health, management of cross-infection and biosafety, dental equipment (use and maintenance), and delegating functions (activities performed by dental assistants). This course provides students with basic training in ergonomics for application in clinical practice. The practical follow-up of ergonomics starts during the pre-clinical activities of the Restorative Dentistry course for second year dental students with a total of 90 hours of training. Clinical activities are also carried out during patient care in the Restorative Dentistry course for third year dental students with a total of 90 hours of training [29].

Despite all the changes made in the curricular structure regarding the teaching of ergonomics at School of Dentistry of Araraquara, it was possible to observe that the students had good theoretical knowledge about ergonomics but had difficulty in applying them continuously in practice [30]. This led them to a moderate compliance with the requirements of ergonomic posture [7]. From that, qualitative research was carried out to understand the

difficulties of applying the principles of ergonomics in practice. Garcia et al. 2017 [29] interviewed dental students and observed that the teaching of ergonomics at School of Dentistry of Araraquara allowed them to understand the importance of adopting ergonomic postures for the maintenance of their occupational health. However, when they tried to put the ergonomic requirements into practice, they faced some obstacles, the main one being the visualization and access to the operative field. Presoto et al. 2016 [31] also observed that the difficulty of visualization was raised as a risk factor for musculoskeletal disorders. These two qualitative studies were very important for understanding the need to develop strategies and implement them in the educational environment to facilitate the visualization of the operative field by students [32, 33].

Several studies are currently being conducted by the Research Group on Ergonomics in Dentistry and Occupational Health of School of Dentistry of Araraquara, evaluating the effects of magnification devices, manual dexterity training programs and indirect vision on students' work posture. Regarding indirect vision training, the preliminary results obtained were encouraging, which resulted in the implementation of this program during the pre-clinical training carried out jointly between the courses of Ergonomics in Dentistry and Restorative Dentistry in 2018. All studies conducted since 2000 have been very important for the changes that have occurred in the teaching of ergonomics at School of Dentistry of Araraquara in recent years. It is believed that with the completion of the research that is currently in progress, it will be possible to implement new teaching strategies that will further contribute to the reduction of the risk of musculoskeletal disorders related to the postural factor.

4. CONCLUSION

Although the acquisition of ergonomics knowledge can occur at any time, the early assimilation of knowledge and internalization of dental ergonomics principles can prevent musculoskeletal disorders in dental students. This can be achieved through implementation of ergonomics in the dental curriculum at the beginning of preclinical training and reinforced later in clinical practice. Curricular revision needs to be accompanied by faculty development and timely evaluation in order to identify areas of success as well as those needing improvement. Epidemiologic studies are important in the early identification of students' musculoskeletal symptoms and provide scientific evidence for the customization of ergonomics education programs in the dental curriculum.

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