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EARLY ERGONOMIC STRESS IN DENTAL EDUCATION: CHANGES IN PRESSURE PAIN THRESHOLDS, BODY AWARENESS AND MUSCULOSKELETAL DISCOMFORT AMONG PRECLINICAL DENTAL STUDENTS

DİŞ HEKİMLİĞİ EĞİTİMİNDE ERKEN ERGONOMİK STRES: PREKLİNİK DİŞ HEKİMLİĞİ ÖĞRENCİLERİNDE BASINÇ AĞRI EŞİĞİ, BEDEN FARKINDALIĞI VE KAS-İSKELET SİSTEMİ RAHATSIZLIKLARINDAKİ DEĞİŞİMLER

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ABSTRACT

Objective: Dentistry is widely recognized as an ergonomically challenging profession, with work-related musculoskeletal disorders (WMSDs) often developing early during undergraduate education. While physical workload is heavily studied, how preclinical education affects body awareness and pain sensitivity remains unexamined. This prospective observational study aimed to investigate concurrent changes in self-reported musculoskeletal discomfort, subjective body awareness, and objective pressure pain thresholds (PPT) among third-year dental students during their initial 14-week preclinical training, thereby demonstrating how early ergonomic conditions affect the human body.

Method: Thirty-two voluntary, consenting third-year dental students (17 females, 15 males) were prospectively investigated at baseline and at the end of a 14-week preclinical semester. Students with a history of surgery, congenital musculoskeletal anomalies, or chronic diseases were excluded from the study. Subjective parameters were evaluated using the Body Awareness Questionnaire (BAQ) and the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). Objective tissue hypersensitivity and pain thresholds were mapped via a Baseline® mechanical dolorimeter across validated myofascial trigger points. Statistical significance was set at $p<0.05$.

Results: Following the 14-week curriculum, participants experienced a significant increase in total musculoskeletal discomfort, with CMDQ scores surging significantly ($p<.001$). Importantly, there was a marked decline in body awareness**,** as BAQ scores significantly decreased ($p<.001$). In parallel, algometric tests revealed significant declines in PPT across every tested muscle group throughout the body ($p<.001$).

Conclusion: Preclinical dental practice induced musculoskeletal disorders and impaired body awareness are fully initiated during the earliest stages of dental training. In conclusion, proper ergonomic approaches and preventive rehabilitation strategies must be established during the undergraduate dental education period.

Key Words: Dental Students, Musculoskeletal Diseases, Body Awareness, Pain Threshold, Ergonomics

ÖZ

Amaç: Diş hekimliği, işe bağlı kas-iskelet sistemi hastalıklarının sıklıkla lisans eğitimi sırasında geliştiği, ergonomik açıdan zorlayıcı bir meslektir. Çalışmalarda hekimlerin fiziksel iş yükü incelenmiş, ancak lisans döneminde preklinik dönemin vücut farkındalığı ve ağrı hassasiyeti üzerindeki etkileri henüz araştırılmamıştır. Bu çalışma, üçüncü sınıf diş hekimliği öğrencilerinde ilk 14 haftalık preklinik eğitimlerinin başlangıcında ve sonunda, kas-iskelet sistemi rahatsızlığı, vücut farkındalığı ve objektif basınç ağrı eşiklerindeki (BAE) eşzamanlı değişimleri incelemeyi ve böylece erken dönemdeki ergonomik koşulların vücudu nasıl etkilediğini ortaya koymayı amaçladı.

Yöntem: Çalışmaya katılmaya gönüllü olan ve bilgilendirilmiş onam veren 32 üçüncü sınıf diş hekimliği öğrencisi (17 kadın, 15 erkek) başlangıçta ve 14 haftalık preklinik dönem sonunda prospektif olarak incelendi. Cerrahi öyküsü, doğuştan kas-iskelet sistemi anomalisi veya kronik hastalığı olan öğrenciler çalışmadan dışlandı. Subjektif parametreler Vücut Farkındalığı Anketi (VFA) ve Cornell Kas İskelet Sistemi Rahatsızlık Anketi (CKİSR) kullanılarak değerlendirildi. Artmış doku hipersensitivitesi ve basınç ağrı eşikleri (BAE), miyofasiyal tetik noktaları üzerinden Baseline® marka mekanik dolorimetre aracılığıyla değerlendirildi. İstatistiksel analizlerde anlamlılık düzeyi $p<0.05$ olarak kabul edildi.

Bulgular: On dört haftalık müfredatın ardından katılımcıların CKİSR skorlarının anlamlı şekilde yükselmesiyle ($p<.001$) toplam kas-iskelet sistemi problemlerinde anlamlı bir artış bulundu. Ek olarak, VFA skorlarının anlamlı derecede düştüğü ($p<.001$) ve vücut farkındalığında belirgin bir azalma olduğu görüldü. Paralel olarak algometrik testler, vücut genelinde değerlendirilen her kas grubunda BAE değerlerinde anlamlı düşüşler ortaya koydu ($p<.001$).

Sonuç: Preklinik dönem diş hekimliği uygulamalarının tetiklediği kas-iskelet sistemi bozuklukları ve bozulan beden farkındalığı diş hekimliği eğitiminin henüz en erken aşamalarında başlamaktadır. Sonuç olarak, doğru ergonomik yaklaşımların ve önleyici rehabilitasyon stratejilerinin lisans diş hekimliği eğitimi sürecinde planlanması gerekmektedir.

Anahtar Kelimeler: Diş Hekimliği Öğrencileri, Kas-İskelet Sistemi Hastalıkları, Beden Farkındalığı, Ağrı Eşiği, Ergonomi

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INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) have recently emerged as one of the most critical occupational health concerns among healthcare professionals. Dentistry is widely recognized as one of the most ergonomically challenging professions, with practitioners exhibiting a higher prevalence of work-related musculoskeletal disorders than the general population [1]. The clinical practice of dentistry inherently demands prolonged static postures, repetitive movements, and asymmetric working positions inside a highly restricted and poorly accessible operating field [2,3]. These continuous mechanical loads frequently cause muscle tension, spasms, and localized fatigue, primarily affecting the neck, back, shoulders, and upper extremities, frequently resulting in localized muscle fatigue, micro-traumas, chronic pain, and functional disability [2,4]. Accumulating epidemiological evidence strongly challenges the traditional notion that these physical complications develop exclusively after years of professional registration; instead, it demonstrates that WMSDs can onset early in undergraduate dental education [5-7]. Recent meta-analytic data involving thousands of dental students reveal an alarming annual prevalence of musculoskeletal symptoms, predominantly localized in the neck, shoulders, and lower back [8]. The preclinical training period, specifically the third year of study, marks a critical point where students transition into intensive, hands-on laboratory work. During these preclinical courses, students are forced to master complex fine-motor skills and technical procedures, such as cavity preparations and restorations [6,7]. Because their cognitive and physical efforts are directed toward the technical quality of their work, students commonly neglect basic ergonomic rules. Consequently, asymmetric positions are adopted and repeatedly reinforced, leading to the early onset of musculoskeletal pain even before formal clinical practice with patients begins. Furthermore, a substantial fraction of these undergraduate students report that their symptoms are severe enough to actively disrupt their clinical training, coursework, or normal daily activities. When compared to the general population in the same age group, dental students experience musculoskeletal pain more frequently, highlighting that the educational phase itself serves as the primary induction period for poor postural habits [8].

Body awareness is an important neuro-musculoskeletal aspect that is still overlooked in dental literature, although traditional interventions place a strong emphasis on postural adjustments [9]. Most studies on dental students use only self-reported questionnaires, which are subject to recall bias and lack objective clinical documentation [1]. Current research emphasizes that sustainable occupational health strategies require a combination of objective physical measurements and subjective assessments. In this context, pressure algometry provides a crucial tool to objectively quantify tissue sensitivity and pain thresholds, moving beyond the limitations of purely subjective reporting. To address this gap, the primary aim of this study is to investigate the prospective changes in musculoskeletal discomfort, body awareness, and pressure pain thresholds (PPT) among third-year dental students from the baseline to the end of their intensive 14-week preclinical training. In our institutional curriculum, the third year represents the final and most intensive phase of compulsory preclinical simulation laboratories (phantom courses) before students transition into formal hospital-based clinical rotations. The main novelty of this study is the prospective evaluation of dental students prior to clinical practice through both objective algometric data and subjective questionnaires. Ultimately, this study aims to evaluate early musculoskeletal discomfort, PPT, and body awareness in dental students and provide preventive ergonomic strategies before these students transition into professional dental practice. We hypothesize that intensive preclinical training will increase musculoskeletal discomfort, decrease pressure pain thresholds, and negatively affect body awareness.

METHOD

Study Design and Partipicants

This study is a prospective observational study conducted among 3rd-year students at the University of Health Sciences, Hamidiye Faculty of Dentistry. All participants were informed about the purpose and procedures of the study, and written and verbal informed consent was obtained prior to any measurements. A total of 32 students (17 females, 15 males) who met the inclusion criteria and fully completed both evaluation stages were included in the study. The inclusion criteria were defined as being a 3rd-year dentistry student, signing the informed consent form, and volunteering to participate in the study. Having a history of surgery, a physician-diagnosed condition of scoliosis, fibromyalgia, myofascial pain syndrome, or any chronic disease, as well as the presence of a congenital musculoskeletal anomaly, were considered as exclusion criteria.

A priori sample size calculation was performed using G*Power 3.1. Assuming a medium-to-large effect size (Cohen's dz = 0.60), a significance level of 0.05, and a statistical power of 90%, the minimum required sample size was determined to be 32 participants. Thirty-six participants were recruited to consider the expected dropout rate, which was estimated at approximately 10%.

Data Collection

Assessments of participants were conducted in two stages: before the 14-week intensive preclinical dental training (pre-training), and at the end of this 14-week period (post-training). These second-stage evaluations were performed just before the students took their final exams. Furthermore, in order to standardize the potential impact of the time factor on the data, the evaluations of all students in both the initial and final measurement periods were completed within exactly one week. All assessments were conducted face-to-face at the Physiotherapy and Rehabilitation Laboratory of the University of Health Sciences, with each participant taken in individually in a standard sitting position. To eliminate time-of-day effects on pain thresholds, data collection was standardized to a specific daily timeframe for all participants (11.00-14.00).

Outcome Measures

The evaluation protocol, applied in the same order during both stages, is as follows:

Demographic Information Form: In the first stage, basic demographic and physical characteristics of the students, such as age, height, weight, Body Mass Index (BMI) and dominant upper extremity were recorded.

Body Awareness Questionnaire (BAQ): It is a comprehensive self-report scale that aims to measure an individual's sensitivity to their own normal or abnormal bodily processes (e.g., sleep cycles, physical reactions, onset of illness). In this study, the validated Turkish version of the questionnaire, adapted by Karaca et al., was utilized to assess the participants' body awareness [10].

Cornell Musculoskeletal Discomfort Questionnaire (CMDQ): The CMDQ is a comprehensive subjective data collection tool developed by Cornell University to assess the frequency, severity, and work interference of musculoskeletal symptoms across various body regions. In the present study, evaluations were conducted using the validated Turkish version of the questionnaire, which was cross-culturally adapted, validated, and proven reliable by Erdinç et al [11].

Algometric Measurements: Following the completion of the questionnaires, pain sensitivity and PPT measurements were conducted using a dolorimeter device as an objective method [12]. Baseline® dolorimeter with a measurement capacity of 60 pounds was utilized. Bilateral (right and left) measurements were obtained in lb/cm² over myofascial trigger points with international validity in the literature *(M. suboccipital, M. upper trapezius, M. rhomboid, M. pectoralis major, M. supinator, M. adductor magnus ve M.*

gastrocnemius). Algometric measurement is a physical method that objectively quantifies pain sensitivity in muscles or tissues. Measurements were performed three times at 1-minute intervals for each myofascial trigger point, and the average values were recorded. In order to eliminate practitioner-induced bias and to ensure full standardization, all measurements were consistently performed by the same physiotherapist. The rate of pressure application was standardized at a constant increase (approximately 0.5 kg/cm²/s) and the investigator was trained prior to the study to maintain this standardized application rate consistently. Additionally, to ensure evaluator blinding, the display screen on the dolorimeter device was read and recorded on the forms by an independent student.

Ethical Approval

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the University of Health Sciences Hamidiye Scientific Research Ethics Committee (date: 18.05.2023, decision number: 10/7). Institutional permission was granted by the relevant authorities, and all participating students provided written informed consent prior to their inclusion in the study.

Statistical Analysis

SPSS v22. Software (IBM Corp., Armonk, NY) was used for analysing the data. Normality of the data was assessed with the Shapiro–Wilk test and visual examination of the histograms. Descriptive statistics for continuous numerical variables are presented as mean±standard deviation (mean±SD) or median (min-max), and for categorical variables, it is expressed as percentage (%). For comparisons, the Paired t-test or the Wilcoxon signed-rank test was used, depending on normality. Effect sizes were calculated to assess the clinical significance of differences between the first and last assessments. Cohen's d (small=0.20, medium=0.50, large=0.80) was calculated for the mean differences of normally distributed continuous variables. For non-parametric comparisons, the effect size r (small=0.10, medium=0.30, large=0.50) was calculated based on the Wilcoxon signed-rank test results [13]. Because multiple outcome comparisons were performed, Holm's Bonferroni adjustment was applied to reduce the probability of Type I error. Statistical significance was evaluated based on the adjusted p-values, with a threshold of $p<0.05$ considered statistically significant.

RESULTS

The study included a total of 36 participants; 32 of them completed the study and were included in the final analyses. The mean age was 21.16 years, and 53.1% were female. Table 1 shows the descriptive characteristics of participants.

Table 1. Descriptive characteristics of participants

Variable		Mean ± SD/n (%)
Age (years)		21.16 ± 1.34
BMI (kg/m²)		23.05 ± 2.64
Gender	Male	17 (53.1%)
	Female	15 (46.9%)

BMI:Body Mass Index.

Body awareness and musculoskeletal discomfort scores before and after the pre-clinical semester are presented in Table 2. A statistically significant decrease in BAQ scores was observed at the end of the 14-week period. However, a statistically significant increase was found in total CMDQ scores (p=0.004).

Regarding CMDQ subscales, significant increases were found in neck, dominant side shoulder, upper back, lower back, dominant side upper arm, dominant side wrist, hip (p=0.004), dominant side forearm and non-dominant side shoulder (p=0.013) scores after the pre-clinical semester. No significant changes were observed in the non-dominant upper arm, forearm, and wrist, or in the upper leg, knee, lower leg, and foot on both sides (p>0.05).

Pressure pain threshold values at all measurement points before and after the 14-week period are presented in Table 3. Significant decreases were observed in pressure pain threshold values at all assessed muscles (p=0.004).

Table 2. Comparison of participants' pre- and post-training BAQ and CMDQ scores

Variable	Pre Mean±SD / Median (min-max)	Post Mean±SD/ Median (min-max)	p	Effect Size (r/d)	Adj. p
BAQ	87.84±8.39	70.03±7.88	<0.001[a]	d=1.78	**0.004**
Total CMDQ Score	75.5 (46 -141)	137 (78 -216)	<0.001[b]	r=0.87	**0.004**
CMDQ Subscale					
Neck	14 (6 - 60)	24 (8 - 60)	<0.001[b]	r=0.67	**0.004**
Shoulder (ds)	12 (0 - 28)	17 (6 - 45)	<0.001[b]	r=0.78	**0.004**
Shoulder (nds)	3 (0 - 21)	6 (0 - 20)	0.001[b]	r=0.57	**0.013**
Upper Back	14 (6 - 32)	28 (14 - 45)	<0.001[b]	r=0.75	**0.004**
Lower Back	16 (2 - 32)	30 (12 - 52)	<0.001[b]	r=0.87	**0.004**
Upper Arm (ds)	2.5 (0 - 12)	6 (0 - 14)	<0.001[b]	r=0.75	**0.004**
Upper Arm (nds)	0.5 (0 - 4)	1 (0 - 8)	0.365[b]	r=0.16	0.576
Forearm (ds)	0 (0 - 4)	0.5 (0 - 12)	<0.001[b]	r=0.57	**0.013**
Forearm (nds)	0 (0 - 2)	0 (0 - 4)	0.288[b]	r=0.19	0.576
Wrist (ds)	0 (0 - 2)	1 (0 - 4)	<0.001[b]	r=0.66	**0.004**
Wrist (nds)	0 (0 - 1)	0 (0 - 4)	0.007[b]	r=0.48	0.070
Hip	0 (0 - 8)	4 (0 - 21)	<0.001[b]	r=0.74	**0.004**
Upper Leg (ds)	0 (0 - 4)	0 (0 - 8)	0.005[b]	r=0.50	0.055
Upper Leg (nds)	0 (0 - 4)	0 (0 - 8)	0.024[b]	r=0.40	0.120
Knee (ds)	0 (0 - 12)	0 (0 - 21)	0.012[b]	r=0.44	0.088
Knee (nds)	0 (0 - 8)	0 (0 - 21)	0.013[b]	r=0.44	0.088
Lower Leg (ds)	0 (0 - 1)	0 (0 - 8)	0.011[b]	r=0.45	0.088
Lower Leg (nds)	0 (0 - 2)	0 (0 - 8)	0.007[b]	r=0.48	0.070
Foot (ds)	0 (0 - 1)	0 (0 - 2)	0.063[b]	r=0.33	0.236
Foot (nds)	0 (0 - 1)	0 (0 - 2)	0.059[b]	r=0.33	0.236

[a]Paired samples t-test; [b]Wilcoxon signed-rank test. Adjusted p-values were calculated using Holm-Bonferroni sequential correction. Values of Adj. p<0.05 are considered statistically significant and highlighted in bold. BAQ:Body Awareness Questionnaire, CMDQ:Cornell Musculoskeletal Discomfort Questionnaire, ds:dominant side, nds:non-dominant side

Table 3. Comparison of participants' pre- and post-training pressure pain threshold (dolorimeter) measurements

Measurement Point (lb/cm²)	Pre Median (min-max)	Post Median (min-max)	p	Effect Size (r)	Adj. p
Suboccipital (ds)	3.21 (2.13-5.53)	2.26 (1.30-3.30)	<0.001	0.81	**0.004**
Suboccipital (nds)	3.33 (2.00-5.23)	2.27 (1.23-3.33)	<0.001	0.87	**0.004**
Upper Trapezius (ds)	3.58 (2.43-9.40)	2.28 (1.13-3.93)	<0.001	0.87	**0.004**
Upper Trapezius (nds)	3.58 (2.13 - 9.73)	2.17 (1.20-3.83)	<0.001	0.87	**0.004**
Rhomboid (ds)	5.27 (3.50-10.17)	3.13 (1.93-5.70)	<0.001	0.87	**0.004**
Rhomboid (nds)	5.30 (3.23-10.60)	3.16 (0.24-5.00)	<0.001	0.87	**0.004**
Pectoralis Major (ds)	3.25 (2.20-6.57)	2.45 (1.43-4.50)	<0.001	0.80	**0.004**
Pectoralis Major (nds)	3.33 (2.03-6.73)	2.35 (1.50-4.77)	<0.001	0.82	**0.004**
Supinator (ds)	3.50 (2.30-5.93)	2.61 (1.57-4.37)	<0.001	0.85	**0.004**
Supinator (nds)	3.33 (2.57-5.60)	2.56 (1.53-4.63)	<0.001	0.83	**0.004**
Adductor Magnus (ds)	5.56 (4.10-9.80)	5.18 (3.87-8.87)	<0.001	0.86	**0.004**
Adductor Magnus (nds)	5.40 (4.13-9.80)	4.18 (0.06-7.77)	<0.001	0.87	**0.004**
Gastrocnemius (ds)	5.01 (3.17-8.50)	3.65 (0.28-7.43)	<0.001	0.77	**0.004**
Gastrocnemius (nds)	5.00 (2.80-8.43)	3.65 (2.10-7.40)	<0.001	0.81	**0.004**

Wilcoxon signed-rank test. Adjusted p-values were calculated using Holm-Bonferroni sequential correction. Values of Adj. p<0.05 are considered statistically significant and highlighted in bold. ds:dominant side, nds:non-dominant side

DISCUSSION

This prospective, observational study investigates concurrent changes in dental students' musculoskeletal discomfort, body awareness, and pressure pain thresholds during the earliest stage of their preclinical education. Our findings revealed a significant increase in overall musculoskeletal discomfort, accompanied by a significant decline in body awareness. Furthermore, algometric assessments revealed a significant decrease in PPT across all examined muscle groups throughout the entire body. This pattern demonstrates that under intense technical demands, students not only suffer from heightened physical distress but also lose their cognitive connection to internal proprioceptive alignment. Our research demonstrates that dental practice induced musculoskeletal problems and pain are fully initiated and established during these earliest months of preclinical training, long before formal clinical rotations begin.

Current literature suggests that demographic and physical variables often do not play a primary role in the prevalence of dental-related musculoskeletal symptoms. In a study by Taib et al. [14], no significant differences in musculoskeletal symptoms were observed across variables such as gender, age, and body mass index. According to Dal et al [15]; age, gender, and years of experience do not independently affect ergonomic risk or posture awareness in dental professionals. Ohlendorf et al. [16], in their large-scale study conducted on dentists and dental students in Germany, found no correlation between chronological age and the prevalence of musculoskeletal symptoms, arguing that the problem originates entirely from the pure ergonomic load experienced during undergraduate years. Our study supports this theory regarding why the age factor is ineffective, as biological degradation begins as early as the first 14 weeks of preclinical training.

In parallel with these findings, Shirzaei et al. [5] evaluated dental students using observational postural assessment scales and reported that 82.3% of students worked under high ergonomic risk, with the highest pain prevalence concentrated in the neck, back, and shoulders. While these previous studies [5,15] utilized tools such as REBA to highlight objective ergonomic risk and poor working postures, our study introduces a crucial dimension by demonstrating how this high postural risk directly translates into reduced PPT. Consequently, our study group demonstrated a uniform physical decline, supporting our view that the decrease in PPT across our sample is caused by the heavy physical and postural demands of the 14-week preclinical curriculum, rather than individual demographic differences. To the best of our knowledge, this is the first study to utilize pressure algometry to objectively quantify tissue hypersensitivity and PPT in this specific preclinical dental student population. Furthermore, in their study on active dental professionals [15], they observed that despite demonstrating moderate postural awareness, dentists concurrently exhibited high-risk working postures, resulting in no significant correlation between posture and awareness. In our sample, this significant decline in body awareness may be a direct consequence of the intense physical demands inherent to preclinical simulation education. During the 14-week semester, students are subjected to continuous static and asymmetric loading, which triggers muscle ischemia and profound fatigue. As the musculoskeletal system becomes severely overworked, a perceptual desensitization occurs, leading to a direct erosion of their proprioceptive focus and body awareness. Additionally, from a cognitive and attentional perspective, preclinical dental training requires high visual and motor precision [17]. Students naturally shift their entire attentional focus outward to the dental substrate and technical accuracy, completely ignoring internal somatic signals. This prolonged neglect causes the central nervous system to habituate to nociceptive and faulty postural inputs, meaning students literally learn to ignore their own physical distress and posture alignment [18]. This critical decline highlights a dangerous paradox: even during early laboratory courses, the foundation for long-term physical damage is already active. Therefore, introducing formal ergonomic training at the absolute beginning of the dental curriculum, rather than waiting for graduation, is an immediate necessity to prevent students from normalizing these harmful patterns.

For instance, studies reported that the shoulders were the most frequently affected region among dentists, with neck and upper back symptoms contributing substantially to functional limitations [5,14,15,19]. Similarly, our objective algometric assessments and subjective scores highlighted the neck, upper back, and right shoulder complex as primary zones of mechanical stress during the early stages of preclinical training. Interestingly, our algometric assessments also revealed a significant decrease in PPT within the lower extremity musculature, specifically the M. Gastrocnemius and hip adductors. These unexpected results suggest that the physical strain of preclinical dental training is not restricted solely to the upper body; rather, it alters the dynamic kinetic chain. From a biomechanical perspective, maintaining a prolonged, static sitting position during dental simulations forces the lower limbs to act as primary postural stabilizers, continuously engaging the adductors and calf muscles to maintain pelvic alignment. Over 14 weeks, this sustained isometric activation likely triggers localized muscle fatigue and peripheral sensitization even in these muscle groups. Continuous postural adaptation and asymmetric weight-bearing are considered to lead to localized muscle fatigue in these stabilizing groups. We suggest that this cumulative neuromuscular strain enhances local tissue vulnerability, ultimately providing a plausible explanation for the observed decline in lower extremity pressure pain thresholds among dental students. Ignoring these early changes causes a direct risk to students' future careers, as unmanaged musculoskeletal disorders have severe long-term professional consequences. Indeed, a study demonstrated that among symptomatic dental practitioners, 45.5% required formal sick leave, 51.5% experienced a forced reduction in clinical activity, and 30.3% had to alter their job duties entirely due to

musculoskeletal pain [20]. These outcomes underscore an urgent necessity for a paradigm shift in dental education, moving away from reactive post-graduation ergonomic interventions toward proactive, preventative frameworks.

The primary strength of our study is following students prospectively right from the start of their practical training. This allows for the determination of the optimal timeline for preventive strategies before faulty postural patterns become irreversible. Although previous studies in the literature have investigated dental students, they often focus on senior students (e.g., 5th-year students) or postgraduate students who have already spent years under clinical strain [6,9,16]. Waiting for symptoms or post-graduation changes is a delayed approach. It is critical to establish early protective rehabilitation programs, structured ergonomic training, and regular physical exercise habits.

Limitations

Several limitations should be considered when interpreting the findings of this study. Firstly, the study was conducted with a relatively small sample size of 32 dental students, which may limit the generalizability of our findings to larger student populations across different universities. Secondly, we did not control for students' habits outside the laboratory, such as daily screen time, sleep quality, and physical fitness levels, which could independently affect their pain and body awareness. Finally, we did not evaluate psychological stress or academic anxiety, both of which are common in early dental training and could potentially confound musculoskeletal symptoms.

CONCLUSION

In conclusion, dental-related physical decline begins as early as the first 14 weeks of preclinical training. These intensive technical demands trigger a significant decrease in body awareness and PPT, affecting both the upper body and lower limb musculature. Integrating mandatory micro-break protocols, posture-correction workshops, proactive ergonomic designs, preventive rehabilitation strategies, and regular physical activity into the preclinical dental curriculum is essential to protect students' future careers**.**

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