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Ergonomic postural knowledge and perceived anatomical pain among dental students in Peru: a cross-sectional study

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ABSTRACT

Background: Dental students are frequently exposed to prolonged clinical postures that may contribute to musculoskeletal discomfort. Adequate knowledge of ergonomic principles is therefore relevant during professional training. **Objective:** To determine the relationship between knowledge of ergonomic working posture and perceived anatomical pain among dental students at a Peruvian university. **Methods:** An observational cross-sectional study was conducted among 86 dental students from the fifth to ninth academic cycles in Trujillo, Peru, selected by simple random sampling. Data were collected using an online questionnaire that assessed ergonomic postural knowledge and perceived anatomical pain. Knowledge was classified as low, moderate, or high, whereas pain intensity was categorized as mild, moderate, intense, or very intense. Absolute and relative frequencies were calculated, and the association between variables was evaluated using Pearson's chi-square test. **Results:** Moderate ergonomic postural knowledge was the most frequent category (67.4%, n = 58), followed by high (20.9%, n = 18) and low knowledge (11.6%, n = 10). Mild anatomical pain was reported by 73.3% (n = 63) of students, moderate pain by 24.4% (n = 21), and intense pain by 2.3% (n = 2); no participant reported very intense pain. A statistically significant association was identified between ergonomic postural knowledge and perceived anatomical pain ($\chi^2 = 16.403$; $p < 0.001$). **Conclusions:** Ergonomic postural knowledge was significantly associated with perceived anatomical pain among dental students, supporting the importance of strengthening ergonomic education during clinical training.

Keywords: Ergonomics; Posture; Pain Perception; Students, Dental; Musculoskeletal Pain.

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Introduction

Work-related musculoskeletal disorders are a major occupational health concern in dentistry because clinical procedures frequently require prolonged static postures, repetitive movements, visual concentration in a restricted operative field, and sustained positioning of the neck, shoulders, back, and upper limbs. These physical demands may contribute to pain, functional limitations, reduced work capacity, and, in more severe cases, long-term professional impairment. A recent systematic review reported that musculoskeletal disorders among dental professionals commonly affect the lower back, shoulders, and neck, with awkward working postures among the most frequently identified occupational risk factors [1].

This problem can begin during undergraduate training. A systematic review and meta-analysis including 16 studies and 3,761 dental students found a high prevalence of musculoskeletal symptoms, particularly in the neck, shoulders, and lower back, and identified poor postural habits and inadequate ergonomic knowledge among the factors associated with these disorders. The yearly prevalence reached approximately 51% for neck symptoms, 45.3% for shoulder symptoms, and 42% for lower-back symptoms, indicating that musculoskeletal complaints may become established before students enter professional practice [2].

Recent studies also suggest that knowledge of ergonomic principles does not necessarily translate into appropriate clinical practice. In South African dental students, Moosa and Bhayat reported an average ergonomic knowledge score of 68%, while only 53% considered themselves able to apply this knowledge successfully; musculoskeletal pain increased from 32% before dental school to 78% during training [3]. Similarly, a study conducted among 402 dental students in Saudi Arabia found that 83.8% reported musculoskeletal pain, most frequently in the lower back, neck, and shoulders, while ergonomic awareness was considered insufficient [4]. In undergraduate dental students from Poland, most participants recognized the importance of dental ergonomics, but 79.3% reported not consistently following basic ergonomic principles during clinical procedures [5].

These findings indicate that ergonomic education should not be limited to theoretical instruction. Objective evaluation of predoctoral dental students has shown medium to high levels of postural risk even after dedicated ergonomic teaching, suggesting that

knowledge, posture, and musculoskeletal outcomes should be considered jointly during dental training [6]. In addition, recent systematic evidence indicates that ergonomic interventions may help reduce postural risk, although the methods used for training and monitoring remain heterogeneous and there is no universally standardized ergonomic prevention program in dental education [7].

Despite the growing international evidence on musculoskeletal disorders and ergonomic practices among dental students, there is still limited information on the relationship between students' knowledge of ergonomic working posture and their perceived anatomical pain in the Peruvian university context. Evaluating this relationship is relevant because identifying deficiencies during clinical training may support the development of educational and preventive strategies before maladaptive postural habits become established in professional practice. Therefore, the objective of this study was to determine the relationship between knowledge of ergonomic working posture and perceived anatomical pain among dental students from the fifth to ninth academic cycles at a Peruvian university

Materials and methods

Study design and setting

An observational, analytical, cross-sectional study with a quantitative approach was conducted among dental students, Trujillo, Peru, during the 2020 academic period. The study evaluated the relationship between knowledge of ergonomic working posture and perceived anatomical pain without manipulation of the study variables. The manuscript was prepared in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for cross-sectional studies [8].

Population, sample and sampling

The target population consisted of dental students undergoing clinical training, while the accessible population comprised 110 students enrolled from the fifth to ninth academic cycles during the study period who met the eligibility criteria according to institutional academic records. The sample size was estimated using the formula for a proportion in a finite population, considering a population size of 110 students, a 95% confidence level ($Z = 1.96$), an expected proportion of

50%, a complementary proportion of 50%, and a maximum allowable error of 5%. The calculated sample consisted of 86 students. Participants were selected using simple random probability sampling, whereby each eligible student had an equal probability of selection. The final analytical sample included 86 participants.

Eligibility criteria

Students enrolled from the fifth to ninth academic cycles who voluntarily agreed to participate in the study were included. Students who were pregnant, had a history of an accident resulting in musculoskeletal sequelae, had a systemic condition that could predispose them to musculoskeletal disorders, or were left-handed were excluded.

Study variables

The primary variables were knowledge of ergonomic working posture and perceived anatomical pain. Ergonomic postural knowledge was assessed using a 12-item questionnaire. Each item contained four response alternatives with only one correct answer. Correct responses were assigned one point and incorrect responses zero points, generating a total score ranging from 0 to 12. Knowledge was categorized as low (0–3 points), moderate (4–8 points), or high (9–12 points).

Perceived anatomical pain was assessed according to anatomical location and perceived intensity. Pain intensity was categorized as mild, moderate, intense, or very intense. The anatomical regions evaluated included the neck, shoulder, arm, hand/wrist, dorsal region, and lumbar region. Age and sex were included as sociodemographic variables. Age was categorized as 15–25 years, 26–35 years, and ≥ 36 years, whereas sex was recorded as male or female.

Data collection instrument

Data were collected using a structured online questionnaire composed of a general information section and two assessment components. The first component evaluated knowledge of ergonomic dental working posture through 12 multiple-choice items addressing anatomical orientation, operator positioning, patient positioning, limb angulation, cervical flexion, and other ergonomic principles relevant to dental practice. Responses were scored dichotomously as correct or incorrect and subsequently classified according to the predefined cut-off points.

The second component assessed the presence of musculoskeletal pain during the previous year, its anatomical location, and perceived intensity. Participants reporting pain identified the affected anatomical region and classified its intensity as mild, moderate, intense, or very intense.

Content validity was assessed in the present study by three dental experts, who independently evaluated the instrument in terms of clarity, objectivity, consistency, coherence, relevance, and sufficiency. The evaluations were favorable across the assessed criteria. The corresponding validation records were retained as part of the study documentation and are available from the corresponding author upon reasonable request.

Data-collection procedures

After obtaining institutional authorization from the Professional School of Dentistry, eligible students were selected according to the sampling procedure. The questionnaire was converted into an electronic format and distributed individually through WhatsApp. Before accessing the study questions, participants received information regarding the purpose and procedures of the research and were asked to provide informed consent.

Participation was voluntary, and the information collected was handled confidentially. Responses were subsequently organized in a Microsoft Excel database and reviewed before statistical analysis.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics, version 25, with Microsoft Excel used for database organization. Categorical variables were summarized using absolute frequencies and percentages. The relationship between ergonomic postural knowledge and perceived anatomical pain was evaluated using Pearson's chi-square test of independence. Statistical significance was established at $p < 0.05$.

Ethical considerations

Institutional authorization for conducting the study was obtained from the Professional School of Dentistry. The research was conducted in accordance with the institutional ethical principles applicable at the time of data collection and with the principles of the Declaration of Helsinki [9]. All participants received information about the study and provided informed consent before completing the questionnaire. Participation was

voluntary, and confidentiality and privacy of the collected information were maintained throughout the study. Data were used exclusively for research purposes.

Results

A total of 86 dental students were included in the analysis. Most participants were aged 26–35 years (73.3%, $n = 63$), followed by those aged ≥ 36 years (19.8%, $n = 17$) and 15–25 years (7.0%, $n = 6$). The sample was equally distributed by sex, with 43 male and 43 female participants (Table 1).

Table 1. Sociodemographic characteristics of the dental students included in the study

Characteristic	n	%
Age, years		
15–25	6	7.0
26–35	63	73.3
≥ 36	17	19.8
Sex		
Male	43	50.0
Female	43	50.0
Total	86	100.0

Note: Percentages were calculated using the total analytical sample ($n = 86$).

Moderate ergonomic postural knowledge was the most frequent category (67.4%, $n = 58$), followed by high (20.9%, $n = 18$) and low knowledge (11.6%, $n = 10$). Regarding perceived anatomical pain, 73.3% ($n = 63$) of participants reported mild pain, 24.4% ($n = 21$) moderate pain, and 2.3% ($n = 2$) intense pain. No participant reported very intense pain (Table 2).

Table 2. Distribution of ergonomic postural knowledge and perceived anatomical pain among dental students

Variable	Category	n	%
Ergonomic postural knowledge	Low	10	11.6
	Moderate	58	67.4
	High	18	20.9
Perceived anatomical pain	Mild	63	73.3
	Moderate	21	24.4
	Intense	2	2.3
	Very intense	0	0.0

Note: Percentages were calculated using the total analytical sample ($n = 86$).

A statistically significant association was observed between ergonomic postural knowledge and perceived anatomical pain (Pearson's $\chi^2 = 16.403$, $df = 4$, $p < 0.001$). Among students with low ergonomic knowledge, 70.0% reported mild pain, 20.0% moderate pain, and 10.0% intense pain. Among those with moderate knowledge, 77.6% reported mild pain and 20.7% moderate pain, whereas among participants with high knowledge, 61.1% reported mild pain and 38.9% moderate pain (Table 3).

When ergonomic postural knowledge and perceived anatomical pain were examined according to age and sex, moderate knowledge predominated in all age groups and in both sexes. Mild pain was the most frequent category among participants aged 26–35 years and ≥ 36 years, whereas moderate pain predominated among those aged 15–25 years. Mild pain was also the most frequent category in both male and female participants (Table 4).

Discussion

The main finding of this study was the statistically significant association between ergonomic postural knowledge and perceived anatomical pain among dental students. Moderate knowledge was the most frequent category, while mild pain predominated overall. Importantly, the distribution of pain differed across knowledge levels, suggesting that theoretical understanding of ergonomic principles and the experience of musculoskeletal discomfort are related, although the cross-sectional design does not allow the direction of this relationship to be established.

This finding is consistent with the study by Akbar, who reported a significant relationship between knowledge of dental ergonomics and the occurrence of musculoskeletal disorders among dental interns and residents in Indonesia [10]. Similarly, recent evidence from South Africa showed that senior dental students had only moderate ergonomic knowledge and that musculoskeletal pain increased substantially during dental training, particularly in the back, neck, and shoulders [3]. A study from Saudi Arabia also found a high prevalence of musculoskeletal pain among dental students together with insufficient ergonomic awareness, reinforcing the relevance of ergonomic education during university training [4].

Table 3. Association between ergonomic postural knowledge and perceived anatomical pain among dental students

Perceived anatomical pain	Low knowledge n (%)	Moderate knowledge n (%)	High knowledge n (%)	Total n (%)
Mild	7 (70.0)	45 (77.6)	11 (61.1)	63 (73.3)
Moderate	2 (20.0)	12 (20.7)	7 (38.9)	21 (24.4)
Intense	1 (10.0)	1 (1.7)	0 (0.0)	2 (2.3)
Very intense	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	10 (100.0)	58 (100.0)	18 (100.0)	86 (100.0)

Note: Percentages in the knowledge columns were calculated within each ergonomic knowledge category. Pearson's $\chi^2 = 16.403$; df = 4; $p < 0.001$.

Table 4. Ergonomic postural knowledge and perceived anatomical pain according to age and sex

Characteristic	n	Low knowledge n (%)	Moderate knowledge n (%)	High knowledge n (%)	Mild pain n (%)	Moderate pain n (%)	Intense pain n (%)
Age, years							
15–25	6	3 (50.0)	2 (33.3)	1 (16.7)	2 (33.3)	4 (66.7)	0 (0.0)
26–35	63	5 (7.9)	45 (71.4)	13 (20.6)	52 (82.5)	10 (15.9)	1 (1.6)
≥36	17	2 (11.8)	11 (64.7)	4 (23.5)	9 (52.9)	7 (41.2)	1 (5.9)
Sex							
Male	43	6 (14.0)	26 (60.5)	11 (25.6)	31 (72.1)	12 (27.9)	0 (0.0)
Female	43	4 (9.3)	32 (74.4)	7 (16.3)	32 (74.4)	9 (20.9)	2 (4.7)

Note: Percentages were calculated within each age or sex category. No participant reported very intense pain; therefore, this category was omitted from the stratified columns to avoid an uninformative column of zeros.

The relationship observed in the present study may partly reflect the gap that can exist between knowing ergonomic principles and applying them consistently during clinical care. A Brazilian study found that students could demonstrate satisfactory theoretical knowledge while still adopting suboptimal positions, particularly involving the eyes and spine, and 75% reported body pain [11]. Likewise, objective ergonomic assessments have shown that dental students may maintain high-risk postures for prolonged periods despite receiving instruction. Blume et al. reported very high RULA scores during standardized dental activities, especially involving the wrists, neck, and trunk [12], whereas Sangalli et al. found medium to extremely high ergonomic risk in predoctoral students even after dedicated ergonomic lectures had been introduced [6].

The high frequency of mild pain found in this study should therefore not be interpreted as evidence that the ergonomic problem is clinically negligible. A 2023 systematic review and meta-analysis involving 3,761

dental students showed that musculoskeletal symptoms were already common during training, particularly in the neck, shoulders, and lower back, and identified poor posture and inadequate ergonomic knowledge among the associated factors [2]. Other recent studies have reported musculoskeletal pain prevalences above 80% among dental students, with static working positions, prolonged clinical activity, and strained postures frequently implicated [13,14]. These findings suggest that symptoms may begin during the formative years and potentially progress if unfavorable work habits become established.

The age-stratified findings also deserve consideration. Moderate ergonomic knowledge predominated among participants aged 26–35 years and those aged ≥36 years, while the youngest group showed a greater proportion of low knowledge. At the same time, moderate pain was proportionally more frequent in the 15–25-year group, whereas mild pain predominated in the older categories. These patterns should be interpreted cautiously because

the age groups were markedly unequal in size, particularly the youngest subgroup. Nevertheless, they are compatible with evidence indicating that ergonomic competence is influenced not only by theoretical exposure but also by clinical experience and repeated practice. Recent studies have shown that students in more advanced stages of training may have greater awareness of ergonomic principles, although this does not necessarily ensure correct application during clinical procedures [5,15].

Regarding sex, the present sample contained equal numbers of male and female students. Mild pain was the most frequent category in both groups, although the two intense-pain cases occurred among women. This isolated finding should not be overinterpreted because of the very small number of intense-pain observations. However, sex differences in musculoskeletal symptoms have been described elsewhere. Sabbagh et al. found significantly more musculoskeletal pain among female dental students [4], and a recent multicenter study similarly reported greater pain intensity and a greater number of painful body sites among women [16]. Conversely, other ergonomic assessments have not identified consistent sex-related differences in objective postural risk [6]. These discrepancies suggest that sex alone is unlikely to explain the occurrence of pain and that working posture, clinical exposure, physical activity, individual biomechanics, and other behavioral or psychosocial factors may also contribute.

From an educational perspective, the findings support integrating ergonomics throughout clinical dental training rather than limiting it to isolated theoretical instruction. Educational strategies should emphasize direct observation of working posture, individualized feedback, repeated reinforcement during clinical sessions, and practical correction of operator–patient positioning. This approach is supported by recent intervention research. Mathew et al. demonstrated that an educational module could improve postural ergonomic awareness and actual working posture among clinical dental trainees [17]. Pejčić et al. also highlighted the importance of combining ergonomic education with preventive measures and physical activity to reduce musculoskeletal risk among dental students [18]. Furthermore, participatory ergonomic interventions have been shown to improve musculoskeletal outcomes and work ability among young dental professionals, indicating that prevention can extend beyond classroom-based instruction [19].

The study has several strengths. It evaluated two clinically relevant aspects of undergraduate dental training ergonomic postural knowledge and perceived pain in a probabilistically selected sample. The use of predefined scoring categories and documented content-validation procedures also provided a structured framework for assessing both variables. In addition, the study addressed students already engaged in clinical training, a stage at which occupational habits may begin to consolidate.

Several limitations should also be considered. First, the cross-sectional design prevents establishing temporality or causality; therefore, the observed association cannot demonstrate that lower ergonomic knowledge caused greater pain or vice versa. Second, the study was conducted at a single university, which limits external generalizability. Third, pain and ergonomic knowledge were assessed using self-reported questionnaires, creating the possibility of recall, information, and social-desirability bias. Fourth, actual clinical posture was not objectively measured using observational or biomechanical instruments such as RULA, motion analysis, or electromyography. Fifth, potential confounding variables including clinical workload, duration of procedures, physical activity, stress, previous musculoskeletal conditions not captured by the eligibility criteria, and use of magnification were not incorporated into an adjusted multivariable analysis. These factors have been associated with musculoskeletal symptoms in previous research and may influence the relationship observed here [12–14,20].

Future studies should therefore use multicenter and longitudinal designs, include objective postural assessment, and incorporate relevant occupational and behavioral covariates in adjusted analyses. Intervention studies should also evaluate whether repeated ergonomic training, direct postural feedback, magnification devices, structured rest periods, exercise programs, or combinations of these strategies can reduce musculoskeletal symptoms over time. Such approaches would help determine whether improvements in ergonomic knowledge are accompanied by measurable changes in clinical posture and lower musculoskeletal burden during dental education [17–20].

Conclusions

A significant association was identified between ergonomic postural knowledge and perceived anatomical pain among dental students from the fifth to ninth

academic cycles. Moderate ergonomic knowledge and mild anatomical pain were the most frequent categories in the study population. These findings indicate that ergonomic knowledge and perceived pain are related during clinical dental training and support the need to reinforce practical ergonomic education as part of undergraduate clinical activities.

Author Contributions Statement (CRediT)

TBA: Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft, Visualization, and Project Administration, Revision and Editing.

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Conflict of Interest

The author declares no financial, institutional, professional, or personal conflicts of interest that could have influenced the conduct or publication of this study.

Data Availability

The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request, subject to applicable ethical and confidentiality considerations.

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