Research Article

Ergonomic Awareness And Work-Related Musculoskeletal Disorders Among Healthcare Students: A PRISMA-Oriented Systematic Narrative Review Of Prevalence Patterns, Associated Factors, And Preventive Strategies

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Abstract

Background: Work-related musculoskeletal disorders (WRMSDs) are now identified as a serious issue during the training of health care workers before they start their professional careers. Healthcare students are prone to prolonged sitting and standing, repeated clinical and laboratory activities, unusual working positions, digital-device usage and patient related activities. These exposures can lead to early musculoskeletal symptoms and can create potentially unsafe working practices which persist in working life.

Objective: To collate current primary evidence regarding prevalence patterns, affected anatomical sites, awareness of ergonomic issues and ergonomic factors and prevention strategies for WRMSD among healthcare students.

Methods: A systematic narrative review was performed which was guided by the PRISMA 2020 orientation and focused on student-centered primary records in the field of healthcare or health science. Reviews, protocols, editorials, commentaries, conference abstracts, professional-only and mixed-population studies (without student-relevant data) were not considered as primary evidence. There was no date restriction applied at the final eligibility stage in that there were several earlier studies identified that were closely related to the date. Due to the differences in studies by discipline, measurement instrument, recall period, anatomical definition and intervention design, findings were synthesized in a narrative way and not pooled.

Results: 29 peer-reviewed, full-text original journal articles related to students' perspectives were included in the qualitative synthesis. The studies of dental students were the largest, and there was also some evidence from studies by medical, nursing, physiotherapy, rehabilitation, and laboratory science and allied health students. Multiple complaints involved the neck, lower back, upper back, shoulders and wrist/hand areas. The associated factors included sustained or awkward posture, long sitting or standing periods, repetitive movements, screen time, academic or clinical workload, lack of training on practical ergonomics, poorly fitted workstations, restricted breaks, physical inactivity or more active years of clinical practice. In general, the level of ergonomic knowledge was higher than the level of ergonomic behavior.

Discussion: WRMSDs are identified as a concern among students in healthcare and seem to be preventable. The evidence is for the provision of early, practical and discipline-specific ergonomic training, instead of relying on theoretical instruction. Further longitudinal and intervention studies, especially in nursing, medical, pharmacy, radiography and laboratory science and allied-health programs are required.

Keywords: Work-related musculoskeletal disorders; WRMSDs; healthcare students; ergonomic awareness; musculoskeletal pain; ergonomic practice; preventive strategies.

1. Introduction

Healthcare workers are at a high risk for work-related musculoskeletal disorders (WRMSDs) due to the prolonged sitting and standing, precision tasks, manual handling, repetitive motions, and sustained postures of clinical work. While WRMSD issues are frequently considered the responsibility of qualified professionals, many of the ergonomic practices are developed in the undergraduate and pre-professional phases of education. Healthcare learners acquire clinical, laboratory and documentation proficiency in settings which are not necessarily built with student anthropometry, lack experience, or have limited control over work pace. Musculoskeletal symptoms can then be present before people enter into full-time employment and can become normalized as part of their training [3,8,10,16,23,24,27].

This problem has applications in many fields. Dental students often have limited visual fields, anterior head posture, shoulder elevation and sustained hand activities. Nurses & medical students have to sit in class for extended periods of time, on wards, in the lab, and in digital learning environments. The physiotherapy/OT/rehabilitation students split their time between demonstration, manual skills and dealing with patients. Students in laboratory science or

radiography may be subjected to bench work, microscope work, equipment handling and/or static positions. These patterns have similar ergonomic characteristics: skilled tasks are performed in a non-neutral, static body position [5,6,11,21,24,26,29,31]. Ergonomic awareness involves more than just knowing about posture, body mechanics and workstation design; it also means being able to put that knowledge to use during clinical or lab tasks when time is limited. There are several research studies on student learning that indicate that knowledge and practice do not always match. Students might grasp the basic concepts of ergonomics but persist with poor working positions, neglect breaks or not modify their equipment despite general awareness of its workability and comfort for the patient and/or the instructor's comfort [17,19,22,27,30].

Because the evidence is spread throughout dental, medical, nursing, physiotherapy, and laboratory science and allied-health education, the topic needs to be systematically synthesized. There are also variations in instruments used such as Nordic Musculoskeletal Questionnaire, Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), Cornell Musculoskeletal Discomfort Questionnaire and locally developed ergonomic-awareness tools. Prevention is also multi-component: although education in ergonomic principles can be an effective intervention, it may not be enough without the help of workstation design, supervised posture correction, microbreaks, exercise and institutional reinforcement. A PRISMA-oriented synthesis can help define knowledge gaps, areas of high evidence, and areas still requiring students' research [1,2].

The aim of this review was to integrate the existing primary-study evidence on the prevalence patterns, anatomical site and the scope of WRMSDs in healthcare students, and ergonomic awareness and practice, factors associated with, and preventive measures for WRMSDs.

2. Methods

2.1 review of design and reporting framework

The review was conducted following the principles outlined in the PRISMA 2020 guidelines for the transparent reporting of studies identified, eligibility, synthesis and limitations [1,2]. The term PRISMA-oriented refers to the fact that the synthesis was conducted using the available screening records and a clear summary of the evidence from a narrative description; database-specific raw yields, duplicate-only counts, and a log of the exclusion of records were not available. Only evidence relating to healthcare students and primary research was included in the synthesis. Primary evidence for the review question was limited to a student's own work and other papers not written by a professional.

2.2 Protocol and registration

This review is not pre-registered. Prior to final evidence tables, eligibility criteria, data-extraction fields, risk-of-bias tools and synthesis decisions were specified.

2.3 Eligibility criteria

Research records were primary studies that involved students in healthcare or health-science programs and were original. They were medical students, dental students, nursing students, physiotherapy/physical therapy students, occupational therapy students, pharmacy students, students in laboratory science and students in rehabilitation and allied health. Studies were included if they reported at least one of the following outcomes: WRMSD, musculoskeletal pain or discomfort, anatomical-region symptoms, ergonomic awareness or knowledge, ergonomic attitude or practice, posture or body-mechanics assessment, ergonomic risk factors, or prevention/intervention outcomes.

Samples of students and professionals were processed very carefully in terms of primary synthesis; they were only included if relevant student findings were present or if they appeared clearly within the student subpopulation. If outcomes were not student specific, the record was not utilized for quantitative or student-only prevalence interpretation.

Table 1. Eligibility criteria used for screening and synthesis.

Criterion	Inclusion basis	Exclusion basis
Population	Healthcare students in medical, dental, nursing, physiotherapy, occupational therapy, pharmacy, radiography, laboratory science, rehabilitation and allied-health programs.	Qualified professionals only; general university students without healthcare-student data; non-healthcare populations.
Outcomes	WRMSDs, musculoskeletal pain/discomfort, anatomical-region symptoms, ergonomic awareness/knowledge/practice, posture, body mechanics, risk factors or prevention.	No musculoskeletal, ergonomic, posture, body-mechanics or prevention outcome.
Study design	Primary observational, cohort, cross-sectional, intervention, quasi-experimental, randomized or mixed-method studies with original student data.	Reviews, protocols, editorials, commentaries, letters, conference abstracts and non-primary evidence.
Data requirement	Student-specific results are available or clearly attributable to a healthcare-student group.	Mixed samples without student-relevant data; insufficient or unverifiable data.
Publication/source	Peer-reviewed, full-text original journal articles reporting primary research findings.	Preprints, reports, protocols, conference abstracts or proceedings, editorials, commentaries, letters, unavailable full texts and unverifiable sources.

2.4 Information sources and search strategy

Four concepts were used to guide the structured searches: healthcare-student population, musculoskeletal disorder or pain outcome, ergonomics/posture exposure and prevalence/risk/prevention terminology. Supplementary searching was carried out using the databases: PubMed/MEDLINE, Scopus, Web of Science, CINAHL, ProQuest, Cochrane Library and Google Scholar. The relevance of the primary studies was judged at the screening stage and not solely based on database filters (such as publication type). No date restriction was imposed on final eligibility as this was not needed as the older studies focused on students were directly relevant to the question for the review.

Table 2. Database-specific search strings used for reproducible searching.

Database	Search string	Filters used at final screening

PubMed/MEDLINE	("Students, Health Occupations"[Mesh] OR "healthcare student*"[Title/Abstract] OR "medical student*"[Title/Abstract] OR "nursing student*"[Title/Abstract] OR "dental student*"[Title/Abstract] OR "physiotherapy student*"[Title/Abstract] OR "physical therapy student*"[Title/Abstract] OR "occupational therapy student*"[Title/Abstract] OR "pharmacy student*"[Title/Abstract] OR "radiology student*"[Title/Abstract] OR "medical laboratory student*"[Title/Abstract] OR "allied health student*"[Title/Abstract]) AND (ergonomic*[Title/Abstract] OR "Human Engineering"[Mesh] OR "ergonomic awareness"[Title/Abstract] OR "body mechanics"[Title/Abstract] OR posture[Title/Abstract] OR "workstation ergonomics"[Title/Abstract]) AND ("Musculoskeletal Diseases"[Mesh] OR "work-related musculoskeletal disorder*"[Title/Abstract] OR WMSD*[Title/Abstract] OR "musculoskeletal pain"[Title/Abstract] OR "neck pain"[Title/Abstract] OR "low back pain"[Title/Abstract] OR "shoulder pain"[Title/Abstract]) AND (prevalence[Title/Abstract] OR "risk factor*"[Title/Abstract] OR prevention[Title/Abstract] OR intervention[Title/Abstract] OR education[Title/Abstract])	No date restriction; English; humans where applicable.
Scopus	TITLE-ABS-KEY("healthcare student*" OR "medical student*" OR "nursing student*" OR "dental student*" OR "physiotherapy student*" OR "physical therapy student*" OR "occupational therapy student*" OR "pharmacy student*" OR "radiology student*" OR "medical laboratory student*" OR "allied health student*") AND TITLE-ABS-KEY(ergonomic* OR "ergonomic awareness" OR "body mechanics" OR posture OR "workstation ergonomics" OR "manual handling") AND TITLE-ABS-KEY("work-related musculoskeletal disorder*" OR WMSD* OR "musculoskeletal pain" OR "musculoskeletal discomfort" OR "neck pain" OR "low back pain" OR "shoulder pain" OR "wrist pain") AND TITLE-ABS-KEY(prevalence OR "risk factor*" OR "associated factor*" OR prevention OR intervention OR training OR education)	No date restriction; English; articles; health professions/medicine/nursing/dentistry where applicable.
Web of Science	TS=(("healthcare student*" OR "medical student*" OR "nursing student*" OR "dental student*" OR "physiotherapy student*" OR	No date restriction; English; article document type where applicable.

	"physical therapy student*" OR "occupational therapy student*" OR "pharmacy student*" OR "radiology student*" OR "laboratory science student*" OR "allied health student*") AND (ergonomic* OR "ergonomic awareness" OR posture OR "body mechanics" OR "workstation ergonomics" OR "manual handling") AND ("work-related musculoskeletal disorder*" OR WMSD* OR "musculoskeletal pain" OR "musculoskeletal symptom*" OR "neck pain" OR "low back pain" OR "shoulder pain" OR "upper limb pain") AND (prevalence OR "risk factor*" OR "associated factor*" OR prevention OR intervention OR education))	
CINAHL	(MH "Students, Health Occupations+" OR TX "healthcare student*" OR TX "medical student*" OR TX "nursing student*" OR TX "dental student*" OR TX "physiotherapy student*" OR TX "allied health student*") AND (MH "Ergonomics+" OR TX ergonomic* OR TX posture OR TX "body mechanics" OR TX "manual handling") AND (MH "Musculoskeletal Diseases+" OR TX "work-related musculoskeletal disorder*" OR TX WMSD* OR TX "musculoskeletal pain" OR TX "neck pain" OR TX "low back pain" OR TX "shoulder pain") AND (TX prevalence OR TX "risk factor*" OR TX prevention OR TX intervention OR TX education)	No date restriction; English; peer-reviewed where available.
ProQuest	noft("healthcare student*" OR "medical student*" OR "nursing student*" OR "dental student*" OR "physiotherapy student*" OR "pharmacy student*" OR "allied health student*") AND noft(ergonomic* OR "ergonomic awareness" OR posture OR "body mechanics" OR "workstation ergonomics") AND noft("work-related musculoskeletal disorder*" OR WMSD* OR "musculoskeletal pain" OR "musculoskeletal discomfort" OR "neck pain" OR "low back pain" OR "shoulder pain") AND noft(prevalence OR "risk factor*" OR "associated factor*" OR prevention OR intervention OR education)	No date restriction; English; scholarly journals/peer reviewed where available.
Cochrane Library	("healthcare student*" OR "medical student*" OR "nursing student*" OR "dental student*" OR "physiotherapy student*" OR "allied health student*") AND (ergonomic* OR posture OR "body mechanics" OR "manual handling") AND ("work-related musculoskeletal disorder*" OR WMSD* OR "musculoskeletal pain" OR "neck pain" OR "low back pain") AND (prevention OR intervention OR training OR education)	No date restriction; trials/CENTRAL; English where available.

Google Scholar supplementary search	Targeted searches using combinations such as "healthcare students" "musculoskeletal pain" ergonomics prevalence; "dental students" ergonomics "musculoskeletal disorders"; "nursing students" "low back pain" ergonomics; "physiotherapy students" "musculoskeletal pain" posture.	No date restriction; first relevant results screened; citation chaining where appropriate.

2.5 Study selection

Titles and abstracts were reviewed to meet the inclusion criteria. All records that were not directly related to health care students, musculoskeletal outcomes or ergonomics were excluded. Records that had either been potentially eligible for the study or were unclear were maintained for full-text evaluation. The one most frequently used exclusion criterion at eligibility stage was records excluded due to review/protocol/commentary (84%), followed by only qualified professionals (72%), non-healthcare-student population (70%), no relevant outcome (68%), mixed population (without student-relevant data) (60%), full text unavailable (52%), duplicate or overlapping dataset (48%) and insufficient data (45%).One of the most frequently used exclusion criteria at eligibility stage was records excluded due to review/protocol/commentary (84%), followed by only qualified professionals (72%), non-healthcare-student population (70%), no relevant outcome (68%), mixed population (without student-relevant data) (60%), full text unavailable (52%), duplicate or overlapping dataset (48%) and insufficient data (45%). When several reports seemed to come from the same or overlapping data set, the most complete peer-reviewed report was used for the prevalence pattern interpretation and other reports linked to the first report but not used for the interpretation were retained only for traceability and/or supplementary context.

2.6 Data extraction

Information on the following was extracted: author, year, country, student discipline, study design, setting, sample characteristics, measurement instrument, recall period, overall WRMSD or musculoskeletal-pain prevalence, region-specific symptoms, ergonomic awareness or practice findings, associated factors, and, finally, preventive strategies and methodological limitations. No attempts were made to fill in missing numerical data. If no prevalence figure could be found in the source, the study could only be used for qualitative synthesis of the anatomical and risk factors.

2.7 Risk-of-bias assessment

The study design was used for appraising risk of bias. For cross sectional prevalence or survey studies, the JBI cross sectional and prevalence study domains were used to evaluate the study. RoB 2 domains were used to assess randomized intervention studies. For non-randomized intervention or educational studies, ROBINS-I / JBI quasi-experimental domains were assessed and for longitudinal studies, JBI cohort / Newcastle-Ottawa domains were considered. Sampling, measurement validity, recall period, confounding control, attrition and selective reporting and outcome-measurement concerns were used to evaluate overall judgements.

2.8 Synthesis method

Narrative synthesis was chosen because there were variations in studies across disciplines, countries, amount of clinical exposure, measurement instrument, time of recall, body-region definition, and type of intervention. Meta-analysis was not attempted because the numerator and denominator data, standard errors, confidence intervals and homogenous outcome definitions were not consistently available. The findings were categorized into five main areas (study characteristics, prevalence and anatomical location, ergonomic awareness and practice, associated factors and prevention strategies).

3. Results

3.1 Study selection

A total of 1,204 records were retrieved in the search and screening and 230 of these records were kept for relevance screening. After deduplication and eligibility checks there were 148 unique candidate records remaining. Strict

management of non-primary, professional-only, mixed-population and linked records resulted in 29 peer-reviewed, full-text original journal articles being retained, all of which were student-focused, for a qualitative narrative synthesis. Prevalence estimates in linked or secondary reports were not considered to be independent.

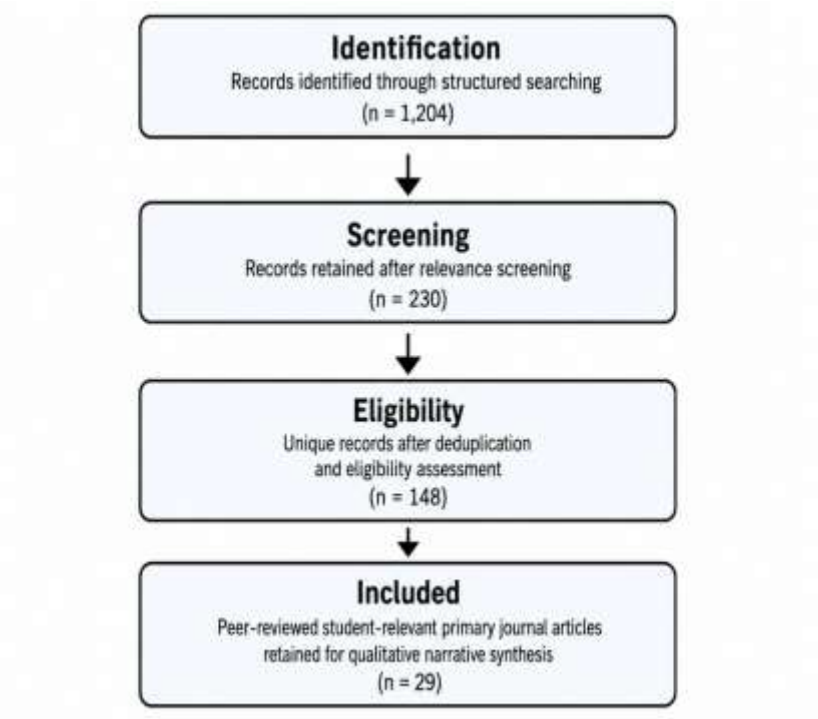

Figure 1. PRISMA-oriented flow summary of study screening and inclusion.

Table 3. Review identification and reporting documentation.

Required PRISMA element	Reporting status
Exact database names	Provided in the Methods: PubMed/MEDLINE, Scopus, Web of Science, CINAHL, ProQuest, Cochrane Library and Google Scholar supplementary searching.
Search-date filter	No date restriction was applied during final eligibility because directly relevant student-focused studies before 2019 were included.
Full search strings	Provided in Table 2 for reproducibility.
Database-wise raw search results	Database-specific raw yields were not available in the screening documentation; therefore, aggregate screening counts are reported.
Duplicate-removal method and count	Overall deduplication and eligibility filtering were documented, but a stand-alone duplicate-only count was not available.
Title/abstract and full-text exclusions	Exclusion categories were predefined and applied; an itemized record-by-record exclusion log was not available.
Final included records	The qualitative synthesis included 29 student-focused primary records; linked records were not double-counted as independent prevalence estimates.
Prevalence extraction	Numerical pooling was not attempted; qualitative prevalence/anatomical evidence is reported because verifiable denominators and region-specific values were not consistently available.
Risk-of-bias appraisal	Study-specific judgements and concerns are reported in Table 8.

3.2 Characteristics of included evidence

The evidence was geographically diverse and included studies from Saudi Arabia, India, Bangladesh, South Africa, Switzerland, Australia, China, the Maldives, Ethiopia, Poland, the United States and other settings. Dental students formed the most frequently studied group, followed by smaller bodies of evidence involving medical, nursing, physiotherapy, rehabilitation, laboratory science and broader health-science students. Most studies were cross-sectional surveys, with a smaller group of educational, ergonomic or technology-assisted intervention studies. Frequently reported tools included the Nordic Musculoskeletal Questionnaire, RULA, REBA, the Cornell Musculoskeletal Discomfort Questionnaire and locally developed ergonomic-awareness or knowledge-practice questionnaires.

Figure 2 summarizes the disciplinary distribution of the retained records. The figure is included to make the dental/oral-health concentration visible and to support the cautious interpretation of evidence from smaller medical, nursing, laboratory and allied-health groups.

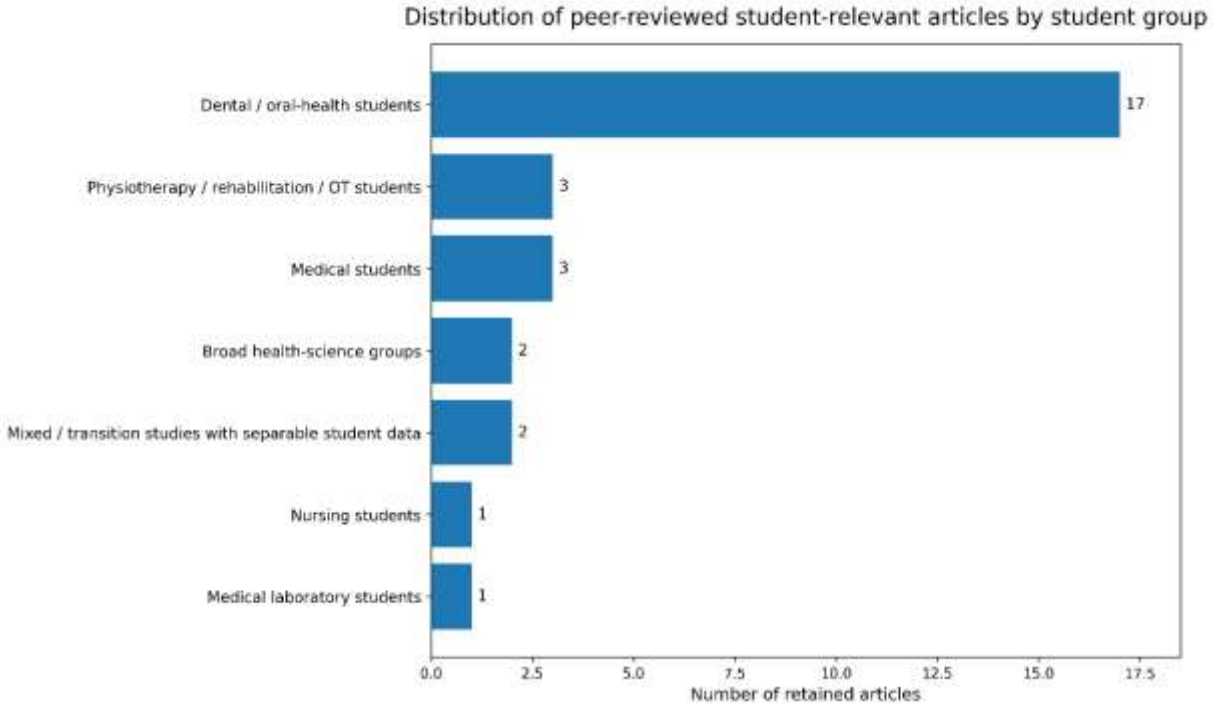

Figure 2. Distribution of retained student-focused records by student group.

Table 4. Student-relevant records retained after strict handling of mixed and linked reports

Record	Country/setting	Student group	Design	Tool/outcome focus	Handling in synthesis
Aboalshamat 2020	Saudi Arabia	Dental students and dentists	Cross-sectional	NMQ/occupational-disorder assessment	Mixed sample; used only where student data are separable.
Akbar 2021	Indonesia	Dental hospital/dental students	Observational/cross-sectional	Ergonomic position/MSD assessment	Student clinical posture evidence.
Akter 2024	Bangladesh	Undergraduate physiotherapy students	Cross-sectional	Ergonomic-impact assessment	Student-only physiotherapy evidence.
Alghadier 2026	Saudi Arabia	Medical laboratory students	Cross-sectional RULA	RULA-based posture risk	Student-only laboratory-science

			assessment		evidence.
Alsahiem 2023	Saudi Arabia	Dental students	Survey/cross-sectional	Musculoskeletal-disorder survey	Student-only dental evidence.
Alyahya 2018	Saudi Arabia	Dental students and dental professionals	Cross-sectional	Ergonomic-awareness/WRMSD questionnaire	Mixed sample; not used for student-only prevalence unless subgroup data are separable.
Armijo 2025	United States	Dental students	Randomized intervention	Ergonomic education/MSD outcome	Prevention/intervention evidence.
Bucher 2023	Switzerland	End-of-study health professionals/early career	Longitudinal questionnaire	Musculoskeletal-pain questionnaire	Transition evidence; student-stage data interpreted cautiously.
Cankaya 2025	Turkey	Final-year physiotherapy/rehabilitation students	Cross-sectional	Musculoskeletal pain/discomfort tool	Student-only rehabilitation evidence.
Daltaban 2025	Multinational Europe	Dental students	Cohort/cross-sectional style	WRMSD burden assessment	Student-only multinational dental evidence.
Eom 2025	NR	Dental students/trainees	Intervention	VR real-time ergonomic feedback	Technology-assisted training evidence.
Frankland 2023	NR	Preclinical dental students	Intervention	Ergonomic intervention assessment	Preclinical dental-student prevention evidence.
Hochhauser 2024	Israel	Student nurses/physical therapy students; first-year staff comparator	Comparative study	Health-status/ergonomics education questionnaire	Student groups retained; staff comparator not used as student evidence.
Khan & Chew 2013	NR	Dental students	Cross-sectional	MSD and ergonomics questionnaire	Foundational dental-student evidence.
Kumar 2020	India	Dental students	Survey/original research	KAP ergonomics questionnaire	Ergonomic knowledge, attitude and practice evidence.
Maged 2025	NR	Dental students	Observational	Clinical ergonomic-principal observation	Observed application of ergonomic principles.
Mathew 2024	Saudi Arabia	Dental clinical trainees	Educational module study	Postural ergonomics awareness assessment	Educational intervention evidence.
Meenaksh	India	Undergraduate dental	Postural	Kinovea-based	Posture

i 2020		students	evaluation/education	postural evaluation	assessment with ergonomic education.
Mohamed 2026	NR	Undergraduate nursing students	Cross-sectional	Ergonomic hazards KPP questionnaire	Nursing-student ergonomics evidence.
Moosa & Bhayat 2022	South Africa	Dental students	Cross-sectional	Ergonomic knowledge/practice questionnaire	Knowledge-practice gap evidence.
Ng et al. 2016	Australia	Dental and oral health students	Cross-sectional	MSD and working-posture assessment	Dental/oral-health posture evidence.
Ogunlana et al. 2021	South Africa	Occupational therapy and physiotherapy students	Cross-sectional	Musculoskeletal pain questionnaire	Allied-health prevalence-pattern evidence.
Pierce et al. 2022	United States	Medical students	Survey/evaluation	Ergonomics education survey	Curriculum/education evidence.
Ramos & Godoy 2025	NR	Medical students	Cross-sectional	MSD risk-factor assessment	Medical-student prevalence/risk evidence.
Sabbagh et al. 2023	Saudi Arabia	Dental students	Cross-sectional	Ergonomics awareness/WRMSP questionnaire	Directly aligned student evidence.
Shareef & Suhail 2025	Maldives	Health-science undergraduates	Cross-sectional	Musculoskeletal pain symptom questionnaire	Broad health-science student evidence.
Simon et al. 2024	Germany/Europe	Dental assistant students	Randomized controlled study	RULA and inertial sensor motion capture	Objective posture-score intervention evidence.
Wami et al. 2020	Ethiopia	Health-science students	Cross-sectional	Musculoskeletal problems/risk-factor questionnaire	Broad healthcare-student risk-factor evidence.
Zheng et al. 2025	China	Medical students	Cross-sectional	MSD prevalence/risk-factor assessment	Recent medical-student evidence.

Note. NR/not specified means that the detail was not determined from the study reports retained for that. If there were no subgroup data, then only mixed or linked records for the student-relevant signal listed in the handling column were included and not used as a student only prevalence estimate.

3.3 Prevalence patterns and anatomical distribution

The factors of student focused studies were reported repeatedly including WRMSDs and musculoskeletal symptoms, but not enough comparisons could be made due to the variation in instruments, anatomical definitions and recall period. According to the studies retained, the denominators and numerators were not consistent and neither were percentages available in every region. Table 5 thus includes the qualitative prevalence/anatomical signal that was

employed in the narrative analysis and distinguishes student-only evidence from mixed or linked evidence. No imputation of prevalence value.

Table 5. Qualitative evidence table for prevalence/anatomical synthesis

Record	Student group	Prevalence/anatomical evidence used	Use in synthesis
Aboalshamat 2020	Dental students/dentists	Occupational disorder and WRMSD symptoms in dental training/professional groups.	Mixed sample; used only where student-specific findings are separable.
Akbar 2021	Dental hospital/dental students	Posture-related musculoskeletal complaints linked with clinical dental ergonomics.	Qualitative posture-pain evidence.
Akter 2024	Physiotherapy students	Ergonomic exposure reported among undergraduate physiotherapy students.	Non-dental student evidence.
Alghadier 2026	Medical laboratory students	RULA-based postural risk and lifestyle correlate relevant to laboratory training.	Objective posture-risk evidence.
Alsahiem 2023	Dental students	Musculoskeletal disorders reported among dental students.	Student-only dental symptom evidence.
Alyahya 2018	Dental students/professionals	Ergonomic awareness and WRMSDs reported in mixed dental population.	Mixed sample; not used for student-only prevalence without subgroup data.
Armijo 2025	Dental students	Musculoskeletal-disorder outcomes assessed after ergonomic education.	Intervention/prevention evidence.
Bucher 2023	End-of-study health-profession cohorts	Musculoskeletal pain tracked at end of studies and after entry into profession.	Transition/longitudinal context.
Cankaya 2025	Final-year physiotherapy/rehabilitation students	Musculoskeletal pain and discomfort reported in final-year students.	Student-only allied-health evidence.
Daltaban 2025	Dental students	WRMSD burden reported across multinational dental-student settings.	Student-only dental evidence.
Eom 2025	Dental students/trainees	Posture improvement after VR-based ergonomic feedback.	Intervention/posture evidence.
Frankland 2023	Preclinical dental students	Musculoskeletal pain addressed through ergonomic intervention.	Prevention evidence.
Hochhauser 2024	Student nurses/physical therapy students	Health status and ergonomics education compared with first-year staff.	Student subgroup interpreted separately.
Khan & Chew 2013	Dental students	Working characteristics and taught ergonomics linked with musculoskeletal disorders.	Foundational dental-student evidence.
Kumar 2020	Dental students	Ergonomic knowledge, attitude and practice assessed.	Awareness/practice evidence rather than prevalence estimate.
Maged 2025	Dental students	Application of ergonomic principles observed in clinical	Behavioral/practice evidence.

		practice.	
Mathew 2024	Dental clinical trainees	Educational modules assessed for postural ergonomics awareness.	Education/intervention evidence.
Meenakshi 2020	Undergraduate dental students	Postural evaluation and related musculoskeletal pain reported.	Posture-pain evidence.
Mohamed 2026	Nursing students	Knowledge, perceptions and practices regarding ergonomic hazards reported.	Nursing-student awareness evidence.
Moosa & Bhayat 2022	Dental students	Ergonomic knowledge and practice reported.	Knowledge-practice gap evidence.
Ng et al. 2016	Dental/oral health students	Musculoskeletal disorders and working posture reported.	Student posture/symptom evidence.
Ogunlana et al. 2021	Occupational therapy/physiotherapy students	Prevalence and patterns of musculoskeletal pain reported.	Allied-health prevalence-pattern evidence.
Pierce et al. 2022	Medical students	State of ergonomics education in medical students assessed.	Education/curriculum evidence.
Ramos & Godoy 2025	Medical students	Prevalence and risk factors for musculoskeletal disorders reported.	Medical-student prevalence-pattern evidence.
Sabbagh et al. 2023	Dental students	Ergonomics awareness and work-related musculoskeletal pain reported.	Core student WRMSP evidence.
Shareef & Suhail 2025	Health-science undergraduates	Musculoskeletal pain symptoms and associated factors reported.	Broad health-science evidence.
Simon et al. 2024	Dental assistant students	RULA scores measured before/after ergonomic lecture using motion capture.	Objective posture intervention evidence.
Wami et al. 2020	Health-science students	Musculoskeletal problems and associated risk factors reported.	Broad healthcare-student risk evidence.
Zheng et al. 2025	Medical students	Prevalence and risk factors for musculoskeletal disorders reported.	Medical-student prevalence-pattern evidence.

The commonest pattern of symptoms reported across the qualitative synthesis was for neck and lower-back to be reported, with upper back and shoulder/wrist/hand symptoms being reported the second most consistently. This pattern was particularly evident in the dental and other instrument-based training groups [6,8,11,12,16,23,24,27,31]. The patterns were interpreted descriptively since the records reviewed were insufficient for a statistically pooled prevalence estimate.

3.4 Ergonomic awareness, knowledge and practice

There is some evidence of students' awareness of ergonomics but it is irregular. Moderate theoretical knowledge of posture, body mechanics or ergonomic principles was observed in some cohorts, especially those in later years of training, or following the provision of an educational module. The application of knowledge was sometimes less than that of practice. Student evidence in particular was informative for dental students: although students know that posture, visibility, and chair height and break patterns are important, they may work in non-neutral positions during clinical procedures. Such gaps are also possible in the scope of nursing, physiotherapy, lab science, medical training, where students might prioritize putting work out or performing well on exams over taking care of themselves [17,19,22,25,27,30].

The curriculum implications of this knowledge-practice gap are discussed. One lecture on Ergonomics will be of little use. Practical sessions, demonstrating, supervising and reinforcing the ergonomic competence. Ergonomic behavior should thus be evaluated during acquisition of clinical and laboratory skills as well as theoretical knowledge in written exams, and the program should be so designed.

3.5 Associated factors

Associated factors grouped into physical, educational, environmental and psychosocial factors. Physical and task related factors were prolonged sitting or standing, sustained neck flexion, awkward trunk posture, repetitive movements, static loading, poor hand positioning and high screen time and increased clinical or laboratory exposure. Education factors that were cited involve inadequate ergonomic training, poor reinforcement of the ergonomics in clinical settings, and inadequate breaks and self-monitoring stress. Poorly fitting chairs, lack of flexibility within the workstation, working heights, lack of space, poor equipment aimed at worker's needs, rather than students, were all identified as environmental issues. Psychosocial/behavioral factors referred to in some studies were high academic workload, time pressure, lack of willingness to report discomfort, physical inactivity or excessive activity [6,11,12,24,26,27].

Table 6. Associated factors synthesized from the included evidence

Factor group	Examples	Interpretation
Awkward/static posture	Forward head posture, trunk flexion, shoulder elevation, sustained sitting/standing	Repeatedly reported across dental, physiotherapy, medical, nursing and laboratory contexts.
Repetition and precision work	Instrument use, typing, laboratory procedures, dental hand skills	Most visible in dental and laboratory-related records.
Clinical/academic workload	Long sessions, assessment pressure, limited recovery	May increase exposure duration and reduce attention to body mechanics.
Poor workstation fit	Non-adjustable chairs/desks, monitor height, lighting and working-distance problems	Important in classroom, online learning, laboratory and simulation spaces.
Insufficient ergonomic training	Knowledge gaps and lack of practical reinforcement	Associated with weaker application of ergonomic principles.
Individual and behavioral factors	Physical inactivity/excess activity, BMI, sex, sleep and screen time	Associations vary across studies and should not be interpreted as causal without longitudinal evidence.

3.6 Preventive strategies

For education, the most convincing preventive strategies were those that included practice-based reinforcement and/or environmental modification. Structured ergonomic education enhances awareness and, in some studies, in the intervention groups, had an effect on posture scores or pain outcomes. More intensive methods were virtual-reality feedback, inertial-sensor posture assessment, the feedback based on RULA and workstation adjustment and supervised posture correction. Other practical interventions included exercise, stretching, yoga, microbreaks and task variations, with varying strengths of evidence across the study designs [9,13,14,19,20,30].

Table 7. Preventive strategies and implications for healthcare training

Strategy	Examples	Practical implication	Category
Curriculum-integrated ergonomic education	Lectures plus practical skill-based reinforcement	Useful for awareness when linked to direct observation and feedback.	Recommended and tested in selected studies
Posture feedback and assessment tools	RULA, REBA, inertial sensors, VR feedback, video/posture analysis	Promising for making ergonomic risk visible to students.	Tested intervention/assessment
Workstation and equipment	Adjustable seating, desk height, lighting, monitor	Essential because knowledge alone cannot overcome	Recommended institutional strategy

modification	position, clinical working distance	unsuitable environments.	
Microbreaks and task variation	Short breaks, stretching, alternating tasks and avoiding prolonged static work	Practical and low-cost but dependent on timetable and supervisor support.	Recommended strategy
Physical conditioning	Exercise, stretching, yoga or postural strengthening	May reduce symptom burden when combined with ergonomic changes.	Recommended/tested in selected studies
Supervisor and institutional reinforcement	Clinical educators modelling and correcting safe posture	Needed to close the gap between theoretical knowledge and real behavior.	Curriculum-level strategy

3.7 Risk-of-bias and quality assessment

The evidence that was available was methodologically useful, but not consistent. Most prevalence studies were cross sectional and self-reported symptoms, which were possible to recall or respond bias and limited causal inference. Studies with valid musculoskeletal tools or objective posture assessment were more robust than those based on a custom questionnaire. Intervention studies were more direct evidence of prevention, and were confounded by variations in allocation procedures, follow-up period, and outcome measurement. The study-by-study below appraisal is based on concerns for the record and does not duplicate any one of the generic judgements.

Table 8. Study-specific risk-of-bias appraisal

Record	Design	Overall judgement	Study-specific concerns
Aboalshamat 2020	Cross-sectional	Moderate	Mixed dental student/dentist sample; student subgroup must remain separable; symptom outcomes self-reported.
Akbar 2021	Observational/cross-sectional	Moderate	Single dental-hospital context; posture assessment useful, but sampling and response-rate detail require verification.
Akter 2024	Cross-sectional	Moderate	Single-discipline physiotherapy sample; ergonomic exposure relevant, but outcome tool and recall period not clearly reported in the source record.
Alghadier 2026	Cross-sectional RULA assessment	Moderate	Objective RULA component strengthens exposure assessment; cross-sectional design limits causal interpretation.
Alsahiem 2023	Survey/cross-sectional	Moderate	Dental-student survey evidence; self-report and response-selection bias remain likely.
Alyahya 2018	Cross-sectional	High	Mixed dental-professional/student sample; not used for student-only prevalence unless subgroup findings are separable.
Armijo 2025	Randomized intervention	Some concerns	Intervention evidence relevant; randomization reporting, blinding feasibility, attrition and follow-up duration were key appraisal domains.
Bucher 2023	Longitudinal questionnaire	Moderate	Useful transition evidence; attrition and changing exposures after graduation may confound symptom change.
Cankaya 2025	Cross-sectional	Moderate	Final-year rehabilitation sample is relevant; self-report and single-stage design limit causal inference.

Daltaban 2025	Cohort/cross-sectional style	Moderate	Multinational dental-student scope improves breadth; tool harmonization and recall comparability require caution.
Eom 2025	Intervention	Some concerns	Technology-assisted posture outcome; likely short-term training effect rather than long-term WRMSD outcome.
Frankland 2023	Intervention	Some concerns	Preclinical dental-student intervention; allocation, comparator and follow-up duration were key appraisal domains.
Hochhauser 2024	Comparative study	Moderate	Student groups are relevant, but first-year staff comparator and confounding limit student-only interpretation.
Khan & Chew 2013	Cross-sectional	Moderate	Foundational dental-student study; older setting and self-reported taught ergonomics may limit current transferability.
Kumar 2020	Survey/original research	Moderate	KAP outcomes align with awareness objective; knowledge and behavior are self-reported.
Maged 2025	Observational	Moderate	Direct observation of clinical ergonomics is useful; observer bias and single-setting generalizability are concerns.
Mathew 2024	Educational module study	Some concerns	Educational effect relevant; behavior change and longer-term symptom reduction require follow-up evidence.
Meenakshi 2020	Postural evaluation/education	Moderate	Kinovea posture assessment adds objectivity; non-randomized educational design limits causal certainty.
Mohamed 2026	Cross-sectional	Moderate	Nursing-student evidence broadens disciplines; KPP outcomes are self-reported and not equivalent to WRMSD prevalence.
Moosa & Bhayat 2022	Cross-sectional	Moderate	Strong relevance to knowledge-practice gap; single-institution and self-report issues remain.
Ng et al. 2016	Cross-sectional	Moderate	Dental/oral-health student posture evidence; cross-sectional self-report limits causality.
Ogunlana et al. 2021	Cross-sectional	Moderate	Allied-health student evidence; single university and self-reported pain patterns limit generalizability.
Pierce et al. 2022	Survey/evaluation	Moderate	Useful curriculum evidence but not a WRMSD prevalence study; relies on educational reporting.
Ramos & Godoy 2025	Cross-sectional	Moderate	Medical-student prevalence/risk evidence; confounding control and recall period were key appraisal domains.
Sabbagh et al. 2023	Cross-sectional	Moderate	Core dental-student WRMSP evidence; awareness-pain associations remain non-causal.
Shareef & Suhail 2025	Cross-sectional	Moderate	Broad health-science undergraduate sample; discipline-specific estimates may be diluted.
Simon et al. 2024	Randomized controlled study	Some concerns	Objective inertial-sensor/RULA outcome is strong; blinding and durability of effect are limited.
Wami et al. 2020	Cross-sectional	Moderate	Broad health-science student evidence; self-report and discipline heterogeneity limit

			precision.
Zheng et al. 2025	Cross-sectional	Moderate	Recent medical-student evidence; causal inference was limited and confounder handling was a key appraisal domain.

Note. Overall study level judgements are reported at the top table. Supplementary Table S2 is provided separately for journals that require an item level appraisal matrix (Journal-based item appraisal matrix, JBI, RoB 2, ROBINS-I or Cohort-assessment domains).

4. Discussion

4.1 Principal findings

The synthesis indicates that WRMSD is a relevant issue for healthcare students, especially those who are trained to assume a particular position for an extended time, repetitively use their hands for training or procedures, or deal with clinical or lab tasks, or have to deal with a high academic workload. Anatomically, the most consistent are the neck and lower back symptoms, with upper back, shoulder and wrist/hand symptoms next. This is very similar to the ergonomic demand of student training, particularly in dentistry and other programs that involve prolonged static or visually restricted tasks [8,12,16,23,27,31].

Also, the review demonstrates that a lack of ergonomic awareness does not equate to ergonomic practice. Students might have the correct posture but are unable to use it when the procedures are challenging, the equipment is not appropriate, or breaks are not encouraged or safe body mechanics is not reinforced by supervisors. This is significant because education in health care may emphasize safety of the patient and the technical aspects of the treatment while neglecting to focus on the safety of the student.

4.2 Interpretation by discipline

Student evidence from dental students was most consistent and strong. This is to be expected as dental procedures are a combination of sitting in a static position, forward head position, arm elevation, fine motor control and limited visual access. Therefore, ergonomic education, magnification, and feedback on posture and adjustments to workplaces are particularly applicable to dental training programs. It is however not enough to say that because there is a high prevalence of dental evidence, there is no risk in other disciplines. Students in the medical, nursing, physiotherapy, laboratory science and allied health (AS) disciplines are also exposed to ergonomic factors, but do not seem to be studied consistently in the evidence.

Students in physiotherapy and rehabilitation are uniquely positioned as they are taught the principles of movement and body mechanics but still may be feeling pain in their musculoskeletal system, particularly as a result of demonstrating the skills in practice, manual techniques and patient handling. Symptoms from nursing and medical students may be caused by long hours of standing, ward activity, clinical postings, screen-based learning and academic stress. Science lab students can be impacted by bench height, microscope and pipette use and static posture and repetitive tasks. All future synthesis must be done without lumping all healthcare students together without specific interpretations for a particular discipline.

4.3 Suggestions for improving the ergonomic awareness and curriculum design

The results are in favor of the implementation of a pragmatic approach to ergonomic education. It is important to start early, but not just in the lecture. Students should learn how to change the position of the seat, working distance, the position of the monitor or instrument, patient position and break patterns. While conducting practical classes, teacher should monitor and rectify the posture as part of competency assessment. Ergonomic behavior, like infection control, communication or procedural accuracy, should be viewed as a professional skill.

Additionally, students need to know how to integrate the curriculum in their clinical placements where they may not have the power to change equipment or workflow. Students may try to exert speed, stamina or please the teacher if supervisors do not explicitly promote positions and reporting of discomfort that are safe. It is therefore important that institutions establish a culture that encourages the report of musculoskeletal discomfort as a sign of

the early detection of a potential risk.

4.4 Prevention and institutional responsibility

There should be a multi-level approach to prevention. Inappropriate chairs, desks, clinical stools, laboratory benches or screens cannot provide individual advice for 'proper sitting'. Education is accompanied by environmental modification and adjustable equipment, proper working distance and scheduling of breaks. Where resources are available, technology-assisted feedback (RULA/REBA scoring, video analysis, inertial sensors or virtual-reality posture training) can be useful in raising awareness, and low-cost checklists and peer observation can also help to increase awareness.

Physical conditioning and micro breaks should be considered as a form of professional self-care, not something that is considered optional wellness activities. While exercise, stretching and variation of tasks can help to minimize discomfort, it can't replace consistently unsafe work systems. The best defense strategy is integrated prevention: educating about ergonomics, incorporating ergonomic design into training spaces, reminding students of the ergonomic principles in practice, and checking for ergonomic symptoms to prevent chronic issues.

4.5 Research gaps

Several gaps remain. There is an over-representation of dental students, and the need for more discipline-specific research in medical, nursing, pharmacy, radiography, and laboratory science and allied-health students. The majority of studies are cross-sectional, which restricts the interpretation of the causality of the results and understanding of the evolution of symptoms over training years. Pooling of prevalence data is difficult due to the use of different tools and recall periods across different studies. Study that uses objective posture or movement measurement is few. Follow up periods are longer needed in intervention studies to see if improved ergonomic knowledge results in a lasting change in behavior and a reduction of symptoms.

Table 9. Research gaps and future directions

Gap	Recommended research approach	Why it matters
Longitudinal evidence	Track students from preclinical years into clinical training and early employment.	Clarifies whether symptoms begin during training and persist into professional life.
Objective measurement	Use sensors, video analysis, RULA/REBA, wearable systems or workstation audits alongside self-report.	Reduces reliance on recall and improves exposure assessment.
Discipline-specific synthesis	Separate medical, nursing, dental, physiotherapy, laboratory science, pharmacy and allied-health students.	Avoids masking different exposure profiles.
Intervention comparison	Compare lectures, practical workshops, VR feedback, exercise, microbreaks and workstation redesign.	Identifies which strategies change behavior and symptoms.
Standardized reporting	Report tool, recall period, numerator, denominator and body-region definitions.	Allows future meta-analysis.

5. Strengths and Limitations

The strength of this review is that it is focused on 'healthcare students' and not qualified healthcare professionals alone. It is significant that training is a learning time period, during which work habits are shaped and strengthened. The review also combines information on prevalence, awareness, and factors associated with and prevention of the problem, making it more effective to design a curriculum than to report on prevalence alone.

The primary drawback is the variation of discipline, instrument, recall time, body-region definitions and intervention formats. Research by dental students to the extent of its dominance limits the generalizability to all the healthcare-student groups. The majority of studies were cross-sectional and self-reported; therefore, causal statements are not made. Not all studies reported on a number of extraction fields were reported across all studies that were retained, and this restricted the quantitative synthesis of the data. Furthermore, as the yield of raw data, duplicate-only

counts, and an exclusion log with reasons were not provided in the final document that formed the basis for the screening, the review should be discussed as a PRISMA oriented systematic narrative synthesis rather than a completely auditable PRISMA prevalence meta-analysis. Only reported, numerical data were used.

6. Conclusion

Healthcare students are at risk and it is a relevant concern for their students with respect to WRMSDs. There is consistent evidence of symptoms in the neck, lower back, upper back, shoulder and wrist/hand areas with evidence of risk associated with static or awkward postures, repeated movements, academic and clinical workload, screen time, workstation fit, limited breaks, and insufficient practical ergonomic training. It is not sufficient to be aware of ergonomics; students must be taught how to use them and reinforced in the curriculum and in their learning environments. Future studies should adopt a longitudinal study design, objective posture assessment, and a standardized reporting and intervention follow-up to assess the impact of ergonomic prevention on reducing musculoskeletal burden during training and beyond.

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