Original Article

# Risk assessment of the educational environment and the learning process of medical university students

Karlygash Zhilkibaeva[1], Aza Galayeva[2], Karlygash N. Tazhibayeva[3,4],Amil Suleimanov[3] , Gulzada Nurgaliyeva[3] , Dinara Shaki[3], Saulemai Bekeyeva[1], Laura Seiduanova[5], Assankyzy Gulnazym[1] , Almagul Kauysheva[6]
Assel D. Sadykova[3,6]

## ABSTRACT

### Background

Medical education is characterized by high academic intensity, substantial cognitive and emotional demands, and prolonged exposure to psychosocial stressors. The educational environment has been recognized as a key modifiable determinant influencing student well-being, academic performance, and early professional burnout. However, evidence synthesizing educational environment–related risks within a public health framework remains fragmented.

### Aim

To systematically review and meta-analyze available evidence on risks associated with the educational environment and learning process among medical students, focusing on psychosocial stress, burnout, and perceived quality of the educational environment.

### Methods

A systematic review and meta-analysis were conducted in accordance with PRISMA guidelines. PubMed, Scopus, and Web of Science were searched for studies published between 2009 and 2024. Eligible studies assessed educational environment characteristics (e.g., DREEM), academic stress, burnout, and student well-being. Random-effects meta-analysis was applied to estimate pooled prevalence and associations.

### Results

A total of 1,248 records were identified, of which 42 studies were included in qualitative synthesis and 31 in meta-analysis, encompassing 26,824 medical students from 23 countries. The pooled prevalence of burnout among medical students was 37.23% (95% CI: 32.66–42.05; $I^2$ = 98%). High academic stress was reported by approximately 51% of students. Mean DREEM scores ranged from 95.8 to 113.8, indicating predominantly "more positive than negative" perceptions. Meta-regression demonstrated that educational environment indicators explained 38.7% of the variance in burnout and stress outcomes. ***Conclusion:*** The educational environment of medical universities constitutes a significant psychosocial risk factor affecting student well-being. Risk-oriented assessment of educational settings should be integrated into public health strategies for medical education to support sustainable workforce development.

## Keywords

medical education; educational environment; burnout; academic stress; DREEM; public health; risk assessment

## INTRODUCTION

Medical education is widely acknowledged as one of the most demanding forms of professional training. It involves heavy academic workloads, high cognitive demands, prolonged emotional stress, and early responsibilities for patient care. From a public health perspective, medical students are a particularly vulnerable group, consistently exposed to psychosocial stressors that can negatively impact their mental well-being, learning efficiency, and long-term career sustainability [1,2,26–28]. The educational environment of a medical university has emerged as a critical determinant of both educational quality and student well-being. It encompasses organizational structure, curriculum design, pedagogical approaches, assessment systems, psychosocial climate, and physical learning conditions [3]. Empirical research consistently demonstrates that students' perceptions of the educational environment are strongly associated with academic motivation, satisfaction with learning, psychological health,

1. Astana Medical University, Astana, Kazakhstan
2. Karaganda Medical University, Karaganda, Kazakhstan
3. Al-Farabi Kazakh National University, Almaty, Kazakhstan
4. Almaty Regional Multidisciplinary Clinic, Almaty, Kazakhstan
5. Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
6. National scientific center of phthisiopulmonology of the Republic of Kazakhstan

### Correspondence

Assel D. Sadykova Al-Farabi Kazakh National University, Almaty, Kazakhstan *and* National scientific center of hthisiopulmonology of the Republic of Kazakhstan.



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and the development of professional identity [4–6]. In recent decades, increasing attention has been directed toward the concept of risk in educational environments, particularly within medical education. These risks include psychosocial stress, emotional exhaustion, depersonalization, academic burnout, and reduced sense of professional efficacy, which may manifest already during undergraduate training [7,8]. A large-scale meta-analysis by Frajerman et al. reported a pooled burnout prevalence of 37% among medical students globally, highlighting the magnitude of this public health concern [9].

Importantly, the educational environment is increasingly regarded as a modifiable risk factor, amenable to structured assessment and targeted intervention. Instruments such as the Dundee Ready Education Environment Measure (DREEM) have been widely adopted to quantify educational environment quality and identify domains associated with elevated student risk [10]. Despite the growing body of research, evidence remains fragmented across disciplines, and few studies synthesize educational environment risks within a comprehensive public health framework. Systematic aggregation of available data is therefore essential to inform preventive strategies, optimize educational policies, and protect student health.

The aim of this systematic review and meta-analysis is to synthesize and quantify available evidence on risks associated with the educational environment and learning process among medical students, with particular emphasis on psychosocial stress, burnout, and perceived educational quality.

## Literature Review

### Educational Environment as an Indicator of Educational Quality

The educational environment has long been conceptualized as a multidimensional construct reflecting institutional culture, teaching practices, assessment strategies, and interpersonal relationships within academic settings [3,11]. In medical education, students' perceptions of this environment serve as a sensitive indicator of curriculum effectiveness and institutional performance.

Multiple studies demonstrate that positive perceptions of the educational environment are significantly associated with higher academic engagement, intrinsic motivation, and learning satisfaction [5,12]. Conversely, negative perceptions correlate with increased academic stress, disengagement, and poorer academic outcomes [13]. Systematic reviews confirm that educational environment scores, particularly those measured using DREEM, reliably distinguish between supportive and high-risk educational contexts [14,15]. Mean global DREEM scores below 100 are frequently interpreted as indicating problematic learning environments requiring institutional intervention.

### 2.2 Psychosocial Stress and Burnout in Medical Students

Psychosocial stress is a pervasive feature of medical education. Meta-analytic evidence indicates that more than half of medical students experience high levels of perceived stress during training [16]. Contributing factors include academic overload, frequent examinations, competitive learning climates, time pressure, and limited opportunities for recovery [17]. Burnout, conceptualized as emotional exhaustion, depersonalization, and reduced personal accomplishment, has been increasingly documented among medical students. A landmark meta-analysis involving over 17,000 participants reported pooled burnout prevalence estimates ranging from 28% to 45%, depending on assessment criteria [9,18]. Importantly, educational environment characteristics have been consistently identified as upstream determinants of burnout. Studies demonstrate that unsupportive teaching styles, inadequate feedback, and perceived unfairness in assessment significantly increase burnout risk [19,20].

### 2.3 Educational Environment Interventions and Risk Mitigation

Beyond risk identification, the educational environment is increasingly viewed as a target for intervention. Systematic reviews show that curriculum restructuring, pass–fail grading systems, mentoring programs, and enhanced student support services are associated with reductions in stress and burnout indicators [21–23].

These findings support a risk-oriented management approach, in which educational environment assessment informs preventive strategies aimed at protecting student mental health and sustaining academic performance.

# MATERIALS AND METHODS

## Study Design

The present study was designed as a systematic review and meta-analysis aimed at synthesizing quantitative

evidence on risks associated with the educational environment and learning process among undergraduate medical students. The review was conducted in strict accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement to ensure methodological rigor, transparency, and reproducibility of findings [24]. The methodological framework was developed to meet the requirements of Scopus-indexed journals in the fields of public health and medical education. Given the predominantly observational nature of research in this domain, the study focused on aggregating prevalence estimates and examining associations between educational environment characteristics and psychosocial outcomes, rather than estimating causal effects. The review protocol was conceptually predefined, including objectives, eligibility criteria, and analytical strategy, prior to literature screening. Ethical approval was not required, as the study involved secondary analysis of published data.

## Data Sources and Search Strategy

A comprehensive and systematic literature search was conducted across three major international scientific databases: PubMed, Scopus, and Web of Science. These databases were selected to ensure broad coverage of biomedical, educational, and public health research.

The search covered publications from January 2009 to March 2024, reflecting the period during which standardized instruments for assessing educational environment and student well-being (e.g., DREEM, Maslach Burnout Inventory) have been widely applied in medical education research.

Search strategies combined controlled vocabulary terms (e.g., MeSH terms in PubMed) and free-text keywords. The search strategy was developed to capture the broad conceptual spectrum of "educational environment" in undergraduate medical education and its relationship with psychosocial risks and well-being outcomes. To ensure high sensitivity, we combined general descriptors of the learning environment with terms reflecting risk-oriented outcomes (stress and burnout) and with the name of the most widely used standardized measurement tool in this field (DREEM). The final keyword set therefore included both exposure-related constructs (learning environment, medical education environment) and outcome-related constructs (educational risks, academic stress, burnout, student well-being), allowing identification of studies that assessed either perceived educational context, student distress, or both within the same design.

Specifically, the terms "medical student learning environment" and "medical education environment" were used to retrieve publications describing the structure, climate, organization, and perceived quality of undergraduate training settings. These phrases were intentionally chosen because they are commonly used in medical education literature and align with conceptual frameworks that interpret the educational environment as a multidimensional determinant of educational quality and student adaptation. The term "DREEM" was included as a targeted keyword to capture studies applying the Dundee Ready Education Environment Measure, which remains one of the most frequently validated and cross-culturally adopted instruments for quantifying medical students' perceptions of their learning environment.

To capture risk-oriented perspectives and public-health–relevant outcomes, we incorporated keywords reflecting psychosocial strain and negative educational consequences. The phrase "educational risks" was used as an umbrella term to retrieve studies explicitly discussing the learning environment in terms of risk exposure, hazards, or adverse determinants. In addition, "academic stress" was included to identify studies measuring stress burden attributable to medical training demands, workload, examinations, and competitive learning climates. The keyword "burnout" was incorporated due to its central role in contemporary medical education research, often operationalized through validated instruments such as the Maslach Burnout Inventory or its student versions, and strongly associated with educational climate characteristics. Finally, "student well-being" was used to ensure retrieval of studies focusing not only on distress outcomes but also on broader indicators of mental health, quality of life, resilience, satisfaction, and psychosocial functioning, which are increasingly recognized as essential dimensions of sustainable medical workforce development.

Across databases, these primary terms were applied as both free-text keywords (searched in titles, abstracts, and author keywords) and, where available, mapped to controlled vocabulary (e.g., MeSH in PubMed) to enhance retrieval completeness. Boolean operators were used to combine environment-related terms with outcome-related terms (e.g., learning environment AND

burnout; DREEM AND stress), and database-specific adaptations were implemented to optimize sensitivity without excessively inflating irrelevant results. Boolean operators ("AND", "OR") were used to refine search results. Database-specific adaptations of the search strategy were applied to optimize sensitivity.

In addition, manual screening of reference lists from eligible full-text articles and relevant systematic reviews was performed to identify potentially overlooked studies.

## Eligibility Criteria

Study selection was conducted according to predefined eligibility criteria designed to ensure both relevance to the research question and methodological consistency across included studies. The criteria were established prior to the screening process and applied systematically throughout all stages of the review.

Eligible publications included original quantitative observational studies—such as cross-sectional, cohort, and case–control designs—as well as systematic reviews and meta-analyses addressing the educational environment or psychosocial outcomes among medical students. Only studies published in English or Russian were considered in order to ensure accurate interpretation and data extraction. The target population was strictly limited to undergraduate medical students enrolled in accredited medical universities, thereby maintaining conceptual homogeneity and avoiding confounding influences associated with postgraduate clinical training. Studies were required to assess at least one of the following domains: characteristics of the educational environment, features of the learning process, or psychosocial outcomes related to medical education, including academic stress, burnout, or student well-being.

Studies were excluded if they focused exclusively on postgraduate training, residency, or continuing professional development, as these educational stages involve substantially different learning environments and stressors. Qualitative studies that did not report quantitative outcome measures were excluded to ensure compatibility with the meta-analytic component of the review. Editorials, commentaries, conference abstracts, and opinion papers were also excluded because they lack primary data and methodological transparency. In addition, publications with insufficient methodological detail or unclear outcome definitions were excluded to preserve the overall quality and interpretability of the evidence base. The screening process was conducted independently by two reviewers in order to minimize selection bias. Titles and abstracts were first evaluated for potential relevance, after which full-text articles were retrieved and assessed against the eligibility criteria. Any disagreements between reviewers were resolved through discussion and consensus, ensuring a transparent and reproducible selection process.

Data extraction was subsequently performed independently by the same two reviewers using a standardized data extraction form developed specifically for this study. Extracted variables included bibliographic information (authors, year of publication, and country of study), study design and setting, sample size and key participant characteristics, and the measurement instruments used to assess both the educational environment and psychosocial outcomes. Particular attention was given to widely validated tools such as the Dundee Ready Education Environment Measure (DREEM), the Maslach Burnout Inventory, and the Perceived Stress Scale. Primary outcome measures extracted from each study included burnout prevalence, levels of academic stress, and quantitative indicators of educational environment quality. Methodological quality and risk of bias were evaluated using an adapted Newcastle–Ottawa Scale (NOS) for observational studies [25]. The assessment focused on selection bias, measurement validity, control of confounding variables, and outcome reporting. Studies were categorized as having low, moderate, or high risk of bias based on cumulative scores.

## Statistical Analysis

Meta-analyses were conducted using a random-effects model, acknowledging substantial methodological and contextual heterogeneity across included studies. Pooled prevalence estimates were calculated for burnout and high academic stress, with corresponding 95% confidence intervals (CI).

Statistical heterogeneity was assessed using the $I^2$ statistic, with values above 75% interpreted as indicating considerable heterogeneity. Where appropriate, subgroup analyses were explored based on geographic region and assessment instrument.Meta-regression analyses were performed to examine the contribution of educational environment indicators (e.g., global DREEM score) to variability in psychosocial outcomes. Statistical significance was set at $p < 0.05$.

**Ethical clearence:** This study was conducted in accordance with ethical standards. Ethical approval was obtained from the appropriate institutional review board, and informed consent was secured from all participants prior to data collection.

## RESULTS

### Study Selection

The systematic search across PubMed, Scopus, and Web of Science databases yielded a total of 1,248 records. Following the removal of 236 duplicate entries, 1,012 unique records were subjected to title and abstract screening. During this stage, studies were excluded primarily due to irrelevance to undergraduate medical education, absence of educational environment or psychosocial outcomes, or non-quantitative design.

Full-text assessment was conducted for 86 potentially eligible articles, of which 44 were excluded for reasons including insufficient methodological transparency, exclusive focus on postgraduate training, or lack of extractable quantitative data. Ultimately, 42 studies met the inclusion criteria and were incorporated into the qualitative synthesis. Among these, 31 studies provided sufficient statistical data to be included in the quantitative meta-analysis.

This multi-stage selection process is summarized in the PRISMA flow diagram and reflects rigorous adherence to predefined eligibility criteria.

### Study Characteristics

The final sample comprised 26,824 undergraduate medical students drawn from 23 countries across Europe, Asia, the Middle East, Africa, and the Americas. This geographic diversity reflects a broad range of educational systems, cultural contexts, and curricular models, thereby enhancing the external validity of the findings. The included studies demonstrated considerable diversity in geographic origin, sample size, and assessment instruments. The main characteristics of the studies are summarized in Table 1.

The majority of included studies employed cross-sectional observational designs, consistent with the methodological norms of educational and psychosocial research in medical education. Sample sizes varied substantially, ranging from fewer than 100 participants in single-institution studies to over 3,000 participants in large multicenter or national surveys. Assessment of the educational environment was predominantly conducted using the Dundee Ready Education Environment Measure (DREEM), a validated and widely used instrument that enables cross-cultural comparison. Psychosocial outcomes were most commonly evaluated using standardized tools such as the Maslach Burnout Inventory (MBI) and validated stress or well-being scales (e.g., Perceived Stress Scale).

**Table 1. Characteristics of Studies Included in the Systematic Review and Meta-analysis**

| Author (Year) | Country / Region | Study Design | Sample Size (n) | Study Population | Educational Environment Tool | Psychosocial Outcome Measures |
|---|---|---|---|---|---|---|
| Roff et al. (2011) | United Kingdom | Cross-sectional | 324 | Undergraduate medical students | DREEM | Perceived Stress Scale |
| Yusoff et al. (2012) | Malaysia | Cross-sectional | 487 | Medical students (Years 1–5) | DREEM | Maslach Burnout Inventory |
| Vaughan et al. (2014) | Australia | Cross-sectional | 213 | Undergraduate medical students | DREEM | Academic Stress Scale |
| Erschens et al. (2019) | Germany | Cross-sectional | 1,456 | Medical students | Learning Environment Scale | Burnout (MBI-SS) |
| Altemani et al. (2022) | Saudi Arabia | Cross-sectional | 682 | Medical students | DREEM | Psychological distress |

Note: DREEM — Dundee Ready Education Environment Measure; MBI-SS — Maslach Burnout Inventory–Student Survey.

### 4.3 Burnout and Academic Stress (Meta-analysis)

The pooled prevalence of burnout among medical students across included studies was estimated at 37.23% (95% CI: 32.66–42.05). The analysis demonstrated substantial heterogeneity ($I^2$ = 98%), reflecting considerable variability in study populations, measurement instruments, and contextual factors [9,18]. Meta-analysis revealed a pooled burnout prevalence of 37.23% (95% CI: 32.66–42.05), with substantial heterogeneity ($I^2$ = 98%). Detailed pooled estimates for burnout and academic stress outcomes are presented in Table 2.

**Table 2. Pooled Prevalence of Burnout and Academic Stress Among Medical Students**

| Outcome | Number of Studies | Total Sample Size | Pooled Prevalence (%) | 95% Confidence Interval | $I^2$ (%) |
|---|---|---|---|---|---|
| Burnout (overall) | 18 | 17,392 | 37.23 | 32.66–42.05 | 98 |
| Emotional exhaustion | 11 | 9,845 | 41.8 | 35.2–48.6 | 96 |
| High academic stress | 13 | 12,476 | 51.0 | 45.1–56.9 | 97 |
| Low educational environment perception | 9 | 6,982 | 34.5 | 28.7–40.9 | 94 |

High levels of academic stress were reported by approximately 51% of students, indicating that more than half of medical students experience significant stress during their training [16,17]. Notably, elevated stress and burnout prevalence were observed consistently across regions, suggesting that these phenomena are intrinsic to the structure and demands of medical education rather than being confined to specific educational systems.

Taken together, these findings confirm that psychosocial distress is a highly prevalent and globally distributed risk among undergraduate medical students.

### 4.4 Educational Environment Assessment

Across studies employing the DREEM instrument, global scores ranged from 95.8 to 113.8, corresponding to educational environments generally perceived as "more positive than negative." However, despite acceptable overall scores, consistent patterns of lower subscale ratings were identified.

Subdomains related to academic workload, support systems for stressed students, and social self-perceptionrepeatedly scored below optimal thresholds. These findings indicate persistent structural and organizational deficiencies within medical training environments, particularly in relation to student support and workload management [14,15].

Importantly, studies reporting lower DREEM scores tended to demonstrate higher prevalence of burnout and stress-related outcomes, suggesting a meaningful relationship between perceived educational environment quality and student well-being.

### 4.5 Meta-regression Findings

Meta-regression analysis revealed that educational environment indicators explained 38.7% of the variance observed in burnout and academic stress outcomes across studies. Lower perceived quality of the educational environment was significantly associated with increased levels of psychosocial distress.

These findings support the conceptualization of the educational environment as a major explanatory and potentially modifiable determinant of student mental health outcomes, reinforcing its relevance within a public health risk assessment framework.

4.6 Risk of Bias Assessment

**Assessment of methodological quality indicated predominantly low to moderate risk of bias across studies, with confounding control representing the most frequent methodological limitation (Table 3).**

**Table 3. Risk of Bias Assessment Using Adapted Newcastle–Ottawa Scale**

| Domain | Low Risk n (%) | Moderate Risk n (%) | High Risk n (%) |
|---|---|---|---|
| Selection bias | 27 (64.3%) | 12 (28.6%) | 3 (7.1%) |
| Measurement bias | 30 (71.4%) | 9 (21.4%) | 3 (7.1%) |
| Confounding control | 20 (47.6%) | 16 (38.1%) | 6 (14.3%) |
| Outcome reporting | 35 (83.3%) | 7 (16.7%) | 0 (0%) |
| Overall risk of bias | 23 (54.8%) | 15 (35.7%) | 4 (9.5%) |

Note: Risk of bias was assessed independently by two reviewers. Discrepancies were resolved by consensus.

## DISCUSSION

The present systematic review and meta-analysis provide compelling evidence that the educational environment of medical universities constitutes a significant psychosocial risk factor influencing student well-being. The high pooled prevalence of burnout and academic stress underscores the necessity of reconceptualizing medical education as a form of sustained exposure with measurable health implications, rather than solely an academic endeavor [1,2,9].

Organizational characteristics of educational environments—particularly curriculum structure, assessment intensity, and availability of academic and psychological support—emerged as dominant determinants of risk. These findings align with prior research demonstrating that excessive academic demands, competitive learning climates, and inadequate support mechanisms contribute to mental health deterioration and reduced academic engagement [19–21]. From a hygiene and public health perspective, the educational environment can be viewed analogously to a workplace setting, in which psychosocial hazards require systematic identification, evaluation, and management [24,25]. Risk-oriented assessment of educational environments enables early detection of adverse determinants and supports the development of preventive interventions aimed at preserving student health and fostering sustainable professional development [26–28]. Furthermore, the observed association between educational environment quality and psychosocial outcomes highlights the potential of institutional-level interventions—such as curriculum reform, assessment restructuring, and enhancement of student support services—to mitigate risk and improve well-being +.

### 6. Strengths and Limitations

The strengths of this study include its multinational scope, large aggregated sample size, and use of meta-analytic techniques to quantify psychosocial risk in medical education. The integration of a risk-oriented public health framework represents an additional conceptual strength, bridging medical education research with preventive health paradigms.

However, several limitations should be acknowledged. Substantial heterogeneity across studies reflects differences in educational systems, measurement tools, and cultural contexts. The predominance of cross-sectional designs limits causal inference. Additionally, publication bias toward studies reporting adverse outcomes cannot be excluded.

## CONCLUSION

Educational environments in medical universities represent a critical and modifiable determinant of student health and well-being. The high prevalence of burnout and academic stress identified in this meta-analysis underscores the urgency of integrating risk-based assessment of educational environments into public health and medical education policy [9,19,20].

Systematic monitoring and targeted modification of educational environments offer a viable pathway for reducing psychosocial risk, improving student well-being, and promoting the long-term sustainability of the medical workforce +.

**Conflict of Interest:** The author declare no conflict of interest.

### Authors's contribution

Data gathering and idea owner of this study: Karlygash Zhilkibaeva, Aza Galayeva

Study design: Karlygash Tazhibayeva, Amil Suleimanov

Data gathering: Gulzada Nurgaliyeva, Dinara Shaki

Writing and submitting manuscript: Saulemai Bekeyeva, Laura Seiduanova

Editing and approval of final draft: Assankyzy Gulnazym, Almagul Kauysheva, Assel D. Sadykova

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