

REVIEW

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Systematic review of the impact of problem-based learning on burnout syndrome in medical students

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Abstract

Medical education increasingly adopts problem-based learning (PBL) to foster clinical reasoning; however, its impact on student mental health remains unclear. A significant knowledge gap persists regarding whether PBL acts as a protective factor or a risk intensifier for burnout, as current evidence is fragmented and heterogeneous. This systematic review synthesizes empirical evidence to inform curricular decisions following PRISMA guidelines. Eight studies ($n = 1,203$) were analyzed, with quality assessed via JBI and CASPe tools. Findings reveal a weighted mean burnout prevalence of 31.8%, primarily linked to systemic stressors such as sleep deprivation rather than the curricular model itself. While most studies found no global difference in burnout prevalence between PBL and traditional models, high-rigor research associates PBL with lower emotional exhaustion and higher professional efficacy. PBL is not a universal protective factor against burnout, as the syndrome is driven by the inherent rigors of medical training regardless of methodology. Its success depends on implementation that balances student autonomy with robust faculty support. Institutions must integrate self-care strategies into the PBL framework to mitigate systemic stress.

Keywords Problem-based learning, PBL, Burnout, Medical students

1 Introduction

The global landscape of medical education faces a growing crisis of student burnout, a multidimensional syndrome characterized by emotional exhaustion, depersonalization, and a diminished sense of personal accomplishment. In this academic setting, students navigate a complex environment where extensive contact hours and early exposure to clinical suffering often exceed their adaptive capacities. While these stressors are inherent to the profession, their interaction with different pedagogical models remains a critical “pain point” for institutional well-being [1–5].

In response, many medical schools have transitioned toward active learning methodologies, with problem-based learning (PBL) at the forefront. PBL is designed to foster autonomy and clinical reasoning through collaborative work. However, a conceptual



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tension exists while the model provides resources like social support and active engagement, it simultaneously imposes high self-regulation demands that may intensify academic stress if not supported by robust tutoring. This dynamic suggests that PBL's influence on burnout is not merely a byproduct of the curriculum, but a result of the balance between its inherent autonomy and the resulting cognitive load [6–8].

Despite the widespread adoption of PBL over the last 50 years, the current evidence regarding its impact on mental health is fragmented and lacks a unified explanatory framework. A critical knowledge gap persists; it remains unresolved whether PBL acts as a protective factor that promotes motivation or if its inherent ambiguity serves as a risk intensifier for burnout. Most existing studies examine these variables in isolation or lack the methodological rigor to allow for generalizable conclusions [4, 9–12].

Consequently, academic burnout, characterized by emotional exhaustion, depersonalization, and a diminished sense of personal accomplishment, is not merely an individual reaction but a response to systemic pressures in medical training. PBL addresses these pressures through pillars like Facilitation and Active Responsibility. However, a conceptual tension exists while these pillars aim to foster autonomy, they also impose high self-regulation demands that can increase cognitive load. This review examines whether the methodology acts as a protective shield or a risk intensifier by analyzing how its core pillars interact with burnout dimension. This systematic review aims to analyze the influence of PBL on burnout syndrome among medical students, providing the theoretical and empirical clarity necessary to optimize student well-being without compromising clinical competence [7, 8].

2 Background

The construct of burnout, originating in the 1970s to describe the erosion of care quality under chronic demands, has evolved into a critical metric for physical and emotional exhaustion in academic populations. According to Maslach's multidimensional model, the syndrome is defined by emotional exhaustion, depersonalization (cynicism), and a diminished sense of personal accomplishment. When transposed to medical education, these dimensions manifest as a response to study demands and perceived incompetence, often leading to severe outcomes such as academic absenteeism, loss of altruism, and even suicidal ideation [13–16].

Medical students are particularly vulnerable, with prevalence rates ranging from 12% to 47% [3, 9, 14, 17–20]. This vulnerability is multifactorial, stemming from a gap between rigorous technical training and a lack of attention to mental health. Factors such as curricular intensification, exposure to suffering, and competitive environments often erode empathy and professional integrity [3, 14, 19, 21].

In response to these systemic stressors, PBL emerged as a student-centered paradigm. Developed at McMaster University, PBL organizes the curriculum around holistic problems to foster deep, integrated learning. Theoretically rooted in constructivism, the model relies on six pillars, including active responsibility, self-directed learning, and facilitation, intended to increase student motivation and confidence [22–24].

However, the relationship between PBL and burnout is non-linear and presents a significant conceptual tension. While the 'facilitation' pillar aims to guide metacognitive reflection and reduce stress, the high demands for autonomy and self-regulation inherent in the model may inadvertently increase cognitive load if implementation

is suboptimal. Consequently, a critical research gap remains: it is unclear whether the active engagement promoted by PBL acts as a protective buffer or whether the model's inherent ambiguity intensifies the risk of burnout [4, 9–12]. This review synthesizes the current evidence to determine how these pedagogical pillars influence the development or mitigation of the syndrome.

3 Methodology

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [24, 26]. To ensure scientific rigor and replicability, the protocol followed the Joanna Briggs Institute (JBI) appraisal criteria [25].

3.1 Research question

To define the research question guiding this systematic review, we followed the PICO strategy proposed by the National Institute for Health and Care Excellence [26]. The PICO acronym refers to population (P), intervention (I), comparison/control (C), and outcome (O). Accordingly, the research question was: *How does the problem-based learning (PBL) methodology affect burnout among medical students?*

3.2 Search strategy

A systematic search was performed in January 2026 across five electronic databases: PubMed, ProQuest, Scopus, ERIC, and Web of Science (WoS). The search strategy was built using the PICO framework (Population, Intervention, Comparison, Outcome). The full Boolean string was adapted for each database; for instance, the PubMed string was: *((student OR alumni* OR estudiant*) AND (medic* OR medicina) AND (“problem based learning” OR “problem-based learning” OR “aprendizaje basado en problemas” OR ABP OR PBL) AND (burnout OR agota* OR desgaste OR quemad*))*. The search was limited to journal articles published between 1998 and 2026. To design comprehensive and unbiased inclusion and exclusion criteria, the PICO strategy was also used [27]. Qualitative, quantitative, and mixed-methods studies were eligible; literature reviews were excluded. Inclusion criteria were medical students following PBL methodology in whom academic burnout was measured. Exclusion criteria were students from other disciplines or graduated physicians, other teaching methodologies, and studies assessing academic stress or other psychiatric disorders rather than burnout.

3.3 Study selection and screening

The selection process was conducted in three stages. First, three investigators (E.C.T., A.A., S.R.Y.) performed an initial title screening. Second, abstracts were reviewed to exclude clearly irrelevant records. Third, two reviewers independently performed a full-text assessment of the remaining reports using Rayyan® software to ensure blinded selection. Any disagreements between the two primary reviewers were resolved through discussion and consensus with the third investigator (Fig. 1).

3.4 Data extraction

A standardized data extraction form was used to ensure consistency. The following variables were collected: author/year, country, sample size, study design, burnout

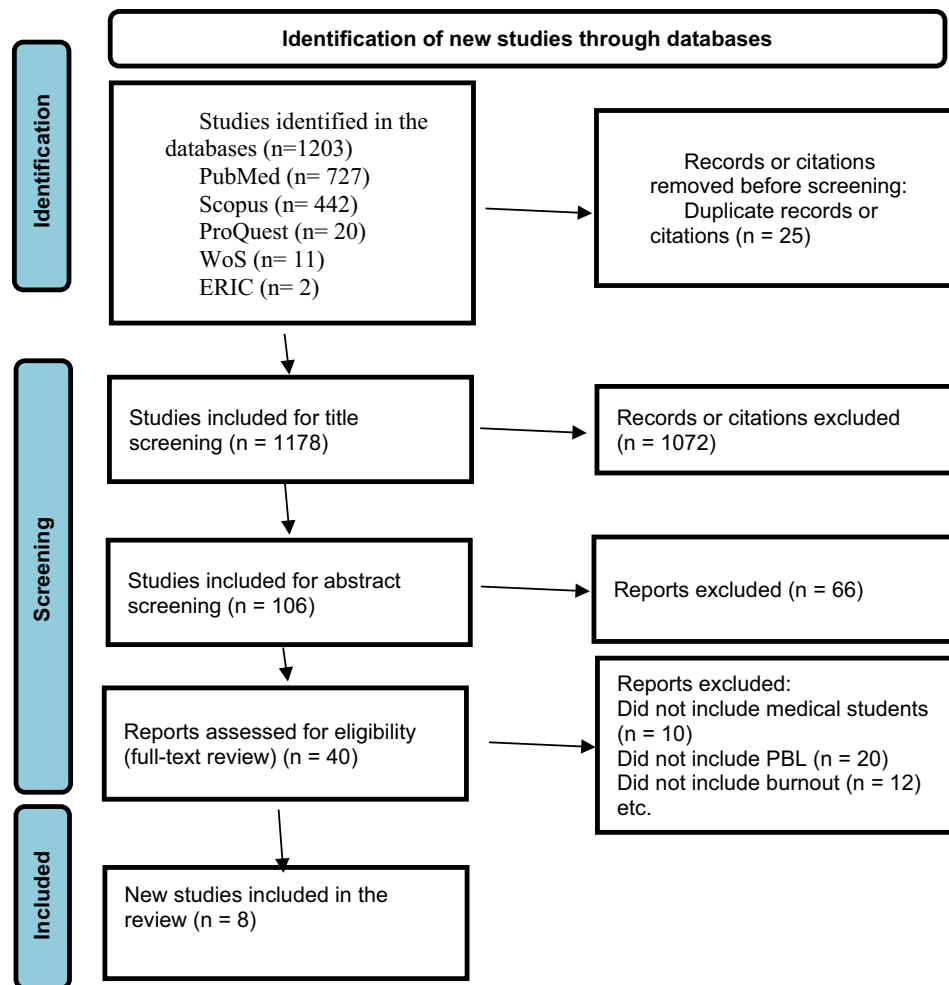


Fig. 1 PRISMA 2020 flow diagram

measurement instrument (e.g., MBI-SS, CBI, OLBI), and key findings regarding the influence of PBL. Data extraction was performed by one investigator and verified by a second to minimize errors.

3.5 Quality assessment and data synthesis

The methodological quality of the included cross-sectional studies was assessed using the *Joanna Briggs Institute (JBI) Checklist for Analytical Cross-Sectional Studies* and CASPe criteria. Each study was scored across eight JBI domains; a score of 7–8 was categorized as “High Quality,” 5–6 as “Moderate,” and below 5 as “Low”.

Due to the significant heterogeneity in burnout measurement tools and the lack of uniform classification criteria across studies, a formal meta-analysis was not feasible. Instead, a narrative synthesis was conducted. Findings were structured thematically, focusing on prevalence rates, comparative outcomes between PBL and traditional models, and the role of confounding variables.

4 Results

4.1 Study selection and characteristics

The systematic search identified eight cross-sectional observational studies conducted in Saudi Arabia, Brazil, Portugal, Pakistan, and the United States [11, 28–34]. The combined sample size across all studies was 1,203 participants, with individual samples ranging from 211 to 658 students. As detailed in Table 1, four studies specifically compared PBL tracks with traditional or lecture-based models, while the remaining four focused on burnout factors within active or mixed curricular settings.

4.2 Methodological quality and risk of bias

Methodological appraisal using the JBI checklist for analytical cross-sectional studies indicated that five studies were rated as high quality and three as moderate quality, with a mean of 7/8 quality criteria met (Table 2). Strengths included use of validated instruments, adequate description of samples, inclusion criteria, and context. Common limitations were the cross-sectional design (precluding causal inference), limited handling of confounders, and, in some cases, convenience sampling or suboptimal response rates. The most frequent risk of bias concerned identification and management of confounding variables; only 62.5% of studies used logistic regression models or multivariable adjustments to isolate the effect of educational methodology from other factors such as gender or socioeconomic status.

CASPe appraisal confirmed that findings were broadly valid and applicable to contemporary medical education contexts (Table 3). Samples were generally representative of medical student populations, although a moderate risk of self-selection bias was identified due to voluntary survey participation. Studies provided prevalence estimates (95% CI), allowing clear comparisons between PBL and traditional models. Objectives were

Table 1 Characteristics of included studies examining PBL and burnout in medical students

Author (year)	Country	Journal	Sample (n)	Burnout instrument	Key findings
Pereira et al. (2014) [28]	Portugal	<i>J Community Med Health Educ</i>	658	MBI-SS	Higher burnout levels reported among students in PBL curricula.
Lucchetti et al. (2018) [29]	Brazil / USA	<i>Acad Psychiatry</i>	211	OLBI	Higher burnout among Brazilian students; institutional context influenced burnout more than curriculum alone.
Barbosa et al. (2018) [30]	Brazil	<i>Clin Pract Epidemiol Ment Health</i>	399	MBI-SS	Burnout prevalence 12%; satisfaction with methodology identified as a protective factor.
Al-Jehani et al. (2020) [31]	Saudi Arabia	<i>Saudi J Med Med Sci</i>	605	CBI	High burnout prevalence in both models; PBL associated with better perception of the learning environment.
Alqifari et al. (2021) [32]	Saudi Arabia	<i>Middle East Curr Psychiatry</i>	336	MBI-SS	Burnout prevalence 8%; academic stress high regardless of model without social support.
Prata et al. (2021) [11]	Brazil	<i>Rev Assoc Med Bras</i>	213	MBI-SS	No significant difference in overall burnout; PBL associated with higher personal accomplishment.
Irshad et al. (2022) [33]	Pakistan	<i>Pak J Med Sci</i>	284	BCSQ-12-SS	Burnout is more strongly associated with external factors (income, sleep) than curricular models.
Jestin et al. (2023) [34]	USA	<i>BMC Med Educ</i>	222	MBI-SS (EE)	Lower emotional exhaustion in PBL compared with lecture-based learning.

Table 2 Methodological quality assessment of included studies using the JBI checklist for analytical cross-sectional studies

Study	C1	C2	C3	C4	C5	C6	C7	C8	Overall quality
Lucchetti et al.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	High
Jestin et al.	Yes	Yes	Yes	No	No	Yes	Yes	No	Moderate
Alqifari et al.	Yes	Yes	Yes	No	Yes	Yes	Yes	No	High
Al-Jehani et al.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	High
Irshad et al.	Yes	Yes	Yes	No	No	Yes	Yes	No	Moderate
Prata et al.	Yes	Yes	Yes	No	Yes	Yes	Yes	No	High
Barbosa et al.	Yes	Yes	Yes	No	Yes	Yes	Yes	No	High
Pereira et al.	No	Yes	Yes	No	No	Yes	Yes	No	Moderate

JBI criteria: C1. Were the criteria for inclusion in the sample clearly defined? C2. Were the study subjects and the setting described in detail? C3. Was the exposure measured in a valid and reliable way? C4. Were objective, standard criteria used for measurement of the condition? C5. Were confounding factors identified? C6. Were strategies to deal with confounding factors stated? C7. Were the outcomes measured in a valid and reliable way? C8. Was appropriate statistical analysis used?

Table 3 Methodological appraisal of included studies using CASPe criteria

Study	Clear research question	Adequate sample	Valid measurement	Confounders controlled	Overall CASPe appraisal
Jestin et al. (2023) [34]	Yes	Yes (n = 222)	Yes (MBI-SS)	Yes (multivariate)	Very high. Direct comparison of PBL vs. LBL with low risk of bias.
Prata et al. (2021) [11]	Yes	Yes (n = 213)	Yes (MBI-SS)	Yes (multivariate)	Very high. Rigorous analysis of associated factors.
Al-Jehani et al. (2020) [31]	Yes	Yes (n = 358)	Yes (MBI-SS)	Partial	High. Large sample; representative of Saudi Arabia context.
Irshad et al. (2022) [33]	Yes	Yes (n = 284)	Yes (BCSQ-12-SS)	Yes	High. Used a different but validated instrument.
Pereira et al. (2014) [28]	Yes	Yes (n = 363)	Yes (MBI-SS)	Partial	High. Strong analysis of coping strategies.
Lucchetti et al. (2018) [29]	Yes	Partial (n = 211)	Yes (OLBI)	No	Moderate–high. Valuable cross-cultural comparison (USA/ Brazil).
Barbosa et al. (2018) [30]	Yes	Yes (n = 215)	Yes (MBI-SS)	No	Moderate–high. Well structured, though primarily descriptive.
Alqifari et al. (2021) [32]	Yes	Yes (n = 336)	Yes (MBI-SS)	No	Moderate–high. Clear results with limited statistical adjustment.

clearly defined and burnout measures were valid; however, sample representativeness and confounder control remained the main methodological vulnerabilities.

Overall, the risk of bias across studies was heterogeneous. Regarding sample selection, three studies were rated as low risk due to large, representative samples and clearly defined inclusion and exclusion criteria. In contrast, two studies were considered high risk because of unclear selection procedures and limited sample sizes, compromising representativeness. The remaining studies showed moderate risk.

In terms of burnout measurement, three studies were classified as moderate risk, mainly due to the use of less commonly applied instruments or the absence of evidence supporting cultural validation. Although tools such as OLBI and BCSQ are valid, their limited comparability with the MBI-SS may reduce result homogeneity.

Concerning the control of confounding variables, two studies were judged as high risk due to insufficient statistical adjustment for key factors such as gender, academic year, workload, and perceived stress. Additionally, comparisons between PBL and traditional methodologies were often conducted without adequately controlling for between-group

differences. Several other studies were rated as moderate risk, as they either lacked comprehensive adjustment for relevant variables or did not employ robust multivariable or stratified analyses to minimize confounding effects.

Finally, with respect to statistical analysis, three studies were classified as moderate risk because they primarily relied on basic group comparison methods without applying advanced adjustment models.

4.3 Burnout prevalence

Burnout prevalence in PBL cohorts ranged from 8% to 55.5%, with a weighted mean prevalence of 31.8%. Variability in these rates was linked to the measurement instrument and the classification criteria used. For instance, studies using the full three-dimensional MBI-SS criteria reported lower prevalence than those using two-dimensional definitions (Table 1). While the MBI-SS was the most common tool, others included the Copenhagen Burnout Inventory (CBI), Oldenburg Burnout Inventory (OLBI), and the BCSQ-12-SS.

4.4 Comparative outcomes - PBL vs. traditional models

Results comparing curricular models were mixed. Four studies identified no statistically significant difference in overall burnout prevalence between PBL and traditional curricula. However, specific dimensions showed divergence: one study reported lower emotional exhaustion in PBL students compared to lecture-based learning, while another reported higher exhaustion levels in the PBL group.

4.5 Associated factors

Across all curricular models, burnout was consistently associated with systemic and personal stressors. Factors linked to higher burnout included sleep deprivation, lower family income, and negative perceptions of the educational environment. Conversely, high satisfaction with the methodology, regular exercise, and robust social or institutional support were identified as significant protective factors.

5 Conclusions

Current evidence, primarily derived from cross-sectional studies, indicates that PBL does not function as a consistent or universal protective factor against burnout syndrome in medical students. Despite its pedagogical benefits, the weighted mean burnout prevalence of 31.8% persists within this model, suggesting that the syndrome is driven by the inherent systemic rigors of medical training, such as high academic load and pre-clinical pressure, which active methodologies alone cannot offset.

Key Implications for Practice: The success of PBL in supporting student well-being is contingent upon proper implementation, which we define as a structural balance between student autonomy and robust faculty facilitation. Specifically, institutions must prioritize tutor skill in guiding metacognitive reflection to reduce the uncertainty-driven stress inherent in self-directed learning. Target interventions toward vulnerable subgroups, particularly female students and those in the preclinical stage, who report higher emotional exhaustion. Integrate self-care and stress management strategies directly into the PBL framework to bridge the gap between technical training and mental health.

Several factors warrant a cautious interpretation of these findings. First, the limited evidence base of only eight eligible studies ($n = 1,203$) reflects a significant “knowledge gap” in specific burnout-PBL research compared to general medical student populations. Second, the high heterogeneity in measurement instruments (e.g., MBI-SS, CBI, OLB) and non-uniform classification criteria prevent a definitive meta-analysis of prevalence. Finally, during the database search, only articles published in English and Spanish were identified. This is noteworthy, as relevant studies may exist in other languages, particularly from Northern European countries, which could represent a potential source of publication bias.

There is a critical need for longitudinal research to track burnout trajectories across different curricular phases. Future studies should utilize standardized burnout measurement tools to allow for robust comparative analysis and investigate how specific PBL components, such as case quality and institutional climate, influence long-term psychological outcomes.

Author contributions

All authors participated in the drafting and critical revision of the manuscript. They have all provided final approval of the version to be published and agree to be accountable for all aspects of the work.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable. As this is a systematic review of previously published literature, this study did not require approval from a research ethics committee for human or animal subjects. The study did not involve the direct participation of human subjects, as data were extracted from secondary sources.

Consent for publication

Not applicable. The manuscript does not contain any individual person's data, images, or videos that could allow for participant identification.

Competing interests

The authors declare no competing interests.

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