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REVIEW ARTICLE

Effectiveness of interventions to prevent and reduce physician occupational burnout: an umbrella review of systematic reviews and meta-analyses

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ABSTRACT

Background: Physician burnout is a critical occupational phenomenon, compromising physician well-being, patient care quality, and healthcare system sustainability. In response, numerous systematic reviews and meta-analyses (SR/MAs) have evaluated interventions aimed at mitigating burnout. However, the proliferation of these reviews has created a complex and often contradictory evidence landscape, making it difficult for decision-makers to identify the most effective strategies. This umbrella review, therefore, synthesizes and critically appraises this body of secondary evidence to provide a clear, high-level summary of what is known about preventing and reducing physician burnout.

Methods: Following Preferred Reporting Items for Systematic Reviews and Meta-analysis guidelines, a systematic search of four major databases was conducted. We included SR/MAs that evaluated individual- or organization-directed interventions to reduce physician burnout. Two reviewers independently performed study selection, data extraction, and quality appraisal using the Joanna Briggs Institute checklist. Findings were synthesized narratively.

Results: Thirteen SR/MAs met the inclusion criteria. A prominent and recurring finding was that organization-directed interventions were associated with larger and more significant reductions in burnout compared to individual-focused strategies. Meta-analyses reported that the effect size for organizational changes was, in some cases, more than double that of individual interventions. While individual approaches like mindfulness demonstrated small, positive effects, particularly on emotional exhaustion, the overall evidence base was limited by significant heterogeneity and methodological weaknesses in the underlying primary studies.

Conclusion: The evidence strongly indicates that organization-directed strategies addressing systemic issues are more effective than interventions targeting individuals alone. The most promising path forward involves a comprehensive, bundled approach that prioritizes fixing the workplace while simultaneously offering supportive, evidence-based resources to physicians. Healthcare organizations must focus on implementing system-level changes to create healthier and more sustainable clinical work environments.

Keywords: Burnout, occupational stress, physician well-being.

Introduction

Physician burnout, an occupational phenomenon defined by the World Health Organization, is a critical and prevalent issue within global healthcare systems [1]. This well-documented occupational health concern is particularly pronounced among resident physicians, with reported prevalence rates ranging from 45% to 57% globally [2-4]. Characterized by emotional exhaustion (EE), depersonalization (DP), and a reduced sense of

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personal accomplishment (PA) [5], burnout adversely impacts physician well-being and patient care quality, while incurring substantial healthcare costs [6,7]. Key drivers of physician burnout include excessive workloads and systemic inefficiencies, with the burdens imposed by electronic health records (EHRs) being a notable contributor [8,9]. Resident physicians exhibit heightened vulnerability to burnout [10]; this increased susceptibility is often linked to factors such as limited professional autonomy, substantial workloads, inadequate institutional support, and comparatively low income [11-14].

In response, numerous interventions have been explored, broadly categorized as individual-focused and organization-directed [15,16]. Individual-focused strategies commonly incorporate elements like mindfulness training, meditation sessions, and psychological workshops [17-22], whereas organizational initiatives often involve adjustments to shift schedules and duration or efforts to improve the learning environment [15,16]. The growing body of primary research has spurred a proliferation of systematic reviews and meta-analyses (SR/MAs) attempting to synthesize these findings [19,21]. However, the sheer volume and often heterogeneous conclusions of these SR/MAs present a challenge for evidence-based decision-making. An earlier umbrella review by Kalani et al. [18] provided an initial synthesis but was limited by the number of SRs available at that time. Since then, the landscape of SR/MAs on physician burnout has continued to expand and diversify, with reviews varying considerably in their scope, included interventions, study populations, and methodological rigor [6,9,15,19,20,22-29]. This inherent heterogeneity, coupled with the rapid pace of new primary research and subsequent SR/MA publications, underscores the need for an updated, overarching synthesis. Furthermore, a comprehensive umbrella review is uniquely positioned to critically appraise this broader body of secondary evidence, identify more robust patterns of intervention effectiveness, and delineate persistent research gaps with greater clarity than individual SR/MAs alone.

Therefore, this umbrella review aims to systematically synthesize and critically appraise evidence from published SR/MAs on the effectiveness of interventions designed to prevent or reduce physician burnout. Our specific objectives are to: (1) characterize the included SR/MAs regarding scope and quality; (2) summarize the spectrum of evaluated interventions; (3) consolidate reported effects on burnout [primarily Maslach Burnout Inventory (MBI) subscales] and performance outcomes; and (4) synthesize overarching conclusions, limitations, and recommendations. This will provide a clearer understanding of effective strategies and guide future research, policy, and practice.

Methods

These SR/MAs were performed following the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement [30].

Eligibility criteria

SR/MAs were considered eligible if they met the following criteria: (1) synthesized primary studies focusing on physicians at any career stage (including medical students and interns) across all medical specialties; (2) evaluated any type of individual-focused or organization-directed intervention designed to prevent or reduce physician burnout; (3) were published as systematic reviews, with or without meta-analysis, which themselves could include primary studies of various designs (e.g., randomized controlled trials, observational studies, and quasi-experimental designs) that utilized comparison groups such as usual care, no intervention, waitlist control, or alternative active interventions; (4) reported on burnout as an outcome in the primary studies, defined by at least one of its core dimensions (e.g., EE, DP, and PA/success), or its overall consequences; and (5) were available as full-text articles.

SR/MAs were excluded if they: (1) were published in a language other than English; (2) mainly concerned non-physician healthcare workers, as the stress profiles of physicians in academic and professional settings are notably different from those of other health practitioners, including nurses and midwive;s (3) were narrative reviews, theoretical papers, educational articles, editorials, commentaries, or conference abstracts; or (4) were primary studies rather than SR/MAs.

Search strategy

Our search for relevant studies encompassed four major databases: Web of Science, PUBMED, Scopus, and Cochrane. We used the following search strategy: (burnout OR “burned out” OR “burned-out” OR DP * OR Derealization* OR “ EE” OR “emotional stress” OR “psychological stress” OR “compassion fatigue”) AND (“Health Personnel” OR “Personnel, Hospital” OR “health care worker” OR “health care workers” OR “health care personnel” OR “health personnel” OR “health-personnel” OR “health provider” OR “health providers” OR “health care provider” OR “health care providers” OR “medical staff” OR “medical personnel” OR “medical professional” OR “medical worker” OR “medical workers” OR “dental personnel” OR “dental staff” OR Dentists OR dentist OR dentists OR “dental assistant” OR “dental assistants” OR “Dental Assistants” OR “nursing staff” OR Nurses OR nurse OR nurses OR “nursing assistant” OR “nursing assistants” OR “Nurses’ Aides” OR “Nurse Midwives” OR midwife OR midwives OR “military-medical personnel” OR Physicians OR physician OR physicians OR doctor OR doctors OR “emergency medical services” OR “Emergency Medical Services” OR “transporting patients” OR “patient transport” OR Ambulances OR “Allied Health Personnel” OR paramedic OR paramedics OR “paramedical personnel” OR Burial OR “burial staff” OR “cleaning workers” OR “cleaner work” OR cleaner OR cleaners). The literature search was conducted from inception till April 17th, 2025.

Study selection

Retrieved citations were managed using EndNote X9 and subsequently exported to a Microsoft Excel sheet for screening. The study selection process involved two sequential stages, each undertaken independently by two reviewers. Initially, titles and abstracts were assessed for relevance. Following this, the full texts of articles that appeared to meet inclusion criteria were evaluated in detail. Disagreements between reviewers at any stage were resolved by mutual discussion, with recourse to a third, senior investigator for final adjudication if consensus was not achieved.

Data extraction

Two reviewers independently extracted relevant information from each included SR/MA using a pre-piloted, standardized data extraction form developed in Microsoft Excel. Extracted data encompassed [31]: general characteristics of the SR/MA (first author, publication year, and objectives); details of the primary studies synthesized (number, design types, participant counts, physician career stages, specialties, and geographic locations); main intervention categories reviewed (e.g., individual-focused, organization-directed, and specific modalities) along with delivery formats and durations where available; primary burnout outcome measures (with particular attention to the MBI and its subscales: EE, DP, and PA, as well as other reported burnout instruments) and any performance-related metrics. Additionally, key findings of the SR/MAs, including reported effect sizes (e.g., Standardized Mean Differences) for burnout and performance, their main conclusions on intervention effectiveness, noted benefits or challenges, limitations of the SR/MA or its primary studies, and author recommendations were systematically retrieved. Any discrepancies between the two reviewers during data extraction were resolved through discussion to achieve consensus.

Quality assessment

The methodological quality of each included SR/MA was independently assessed by two reviewers using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Systematic Reviews and Research Syntheses [32]. This 11-item tool examines aspects such as the clarity of the review question, appropriateness of inclusion criteria, search strategy adequacy, critical appraisal of primary studies, data extraction and synthesis methods, and the soundness of conclusions. Reviewers assigned "Yes," "No," "Unclear," or "Not Applicable" to each item, with disagreements resolved through discussion to achieve consensus, or by a third senior reviewer if necessary. The overall quality assessments were subsequently used to inform the interpretation and synthesis of the findings from the included SR/MAs.

Data synthesis

No new statistical analyses or meta-analyses were conducted for this umbrella review. The evidence synthesis was qualitative, involving the systematic extraction and narrative summarization of the existing results, effect sizes (where available), and conclusions as presented in the included SR/MAs. Key findings were organized and reported descriptively and in tabular format.

Literature search

The initial search of electronic databases (PubMed, Cochrane, Web of Science, and Scopus) yielded 1815 records. After the removal of 304 duplicates, 1,511 unique records underwent title and abstract screening. Following this initial screening, 1,280 records were excluded, leaving 231 potentially relevant studies for full-text assessment. Upon detailed full-text review, 218 articles were further excluded. The primary reasons for exclusion at this stage were: participants were not physicians (n = 134), use of different study designs (n = 58), and no relevant outcomes reported (n = 26). Consequently, a total of 13 systematic reviews met all inclusion criteria and were included in this umbrella review. The study selection process is detailed in the PRISMA flow diagram (Figure 1).

Quality assessment

The methodological quality of the 13 included systematic reviews was assessed using the JBI Critical Appraisal Checklist for Systematic Reviews and Research Syntheses. Overall, the reviews demonstrated generally favorable methodological quality. All 13 reviews clearly stated their research questions, utilized appropriate inclusion criteria, employed adequate search strategies and resources, appropriately combined primary studies, and provided suitable recommendations for policy, practice, and future research. Eleven reviews used appropriate criteria for appraising their primary studies, while this was unclear for two reviews. Twelve reviews reported independent critical appraisal of primary studies and detailed methods to minimize data extraction errors, with these aspects being unclear in one review for each respective item. The assessment of publication bias showed the most variability: six reviews adequately addressed this, four were unclear in their approach, and three did not assess it. Following this appraisal, 11 reviews were directly included. Two reviews initially categorised as "seek further info" due to specific methodological ambiguities were ultimately included after careful consideration of their overall relevance and contribution [20,25]. A detailed JBI checklist assessment for each review is provided in Table 1.

Characteristics of included SR/MAs

The 13 SR/MAs included in this umbrella review were published between 2008 and 2024. Their objectives

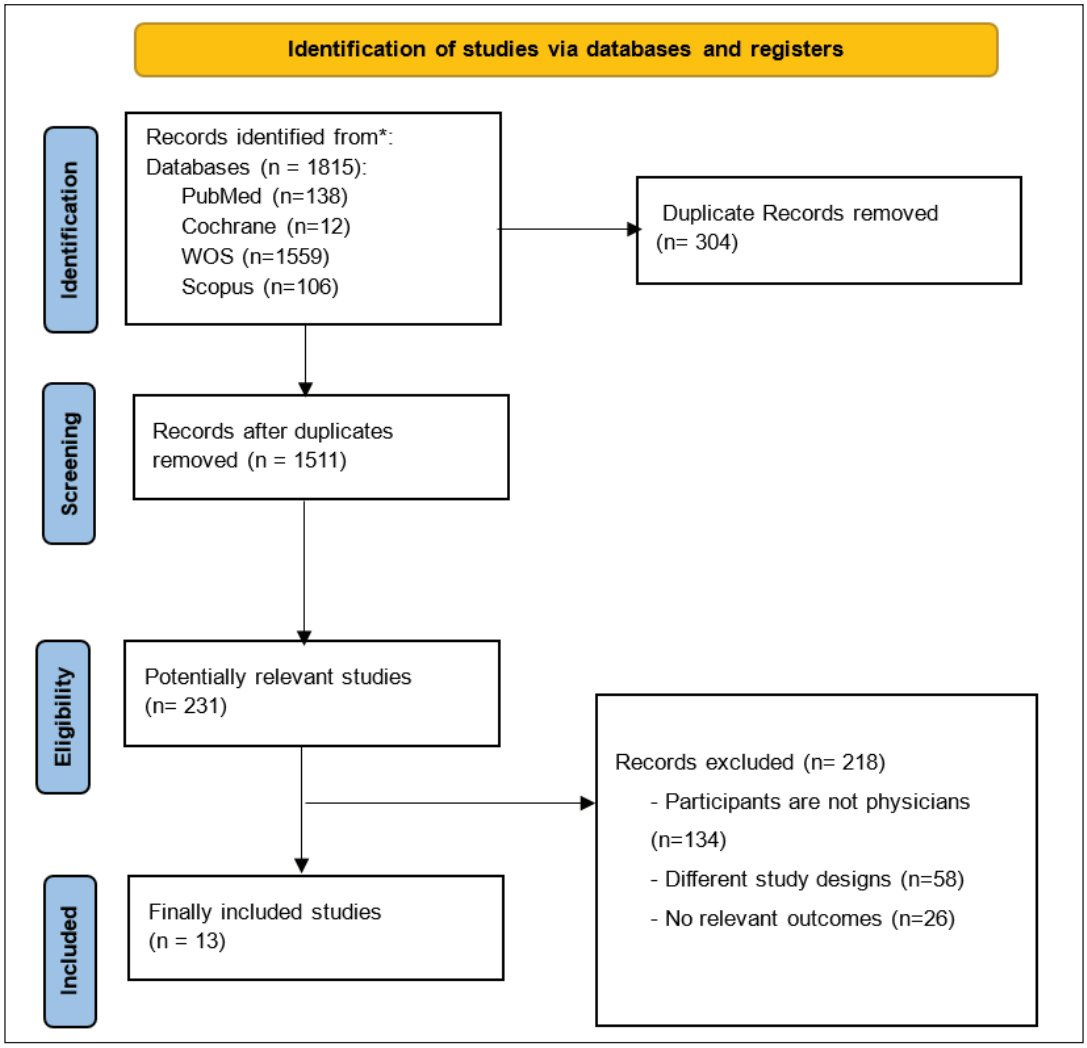

Figure 1. *PRISMA flow diagram*

varied, covering broad evaluations of burnout interventions, specific intervention modalities like mindfulness or digital tools, psychosocial approaches, and interventions within medical education (Table 2).

The sum of primary studies reported across the 13 included SR/MAs was 314, with the number per review ranging from 9 to 52. It is important to note that this cumulative count may overestimate the number of unique primary studies, as individual primary studies are often included in more than one systematic review. The included reviews covered various physician career stages, including residents, specialists, and mixed cohorts. Primary studies within these SR/MAs were conducted across a diverse range of physician specialties, with mixed specialties, primary care, internal medicine, and surgery being common. Geographically, primary studies originated predominantly from the United States, with significant contributions from Europe, Australia, and Canada; three SR/MAs did not report these locations (Table 2). The MBI, particularly its subscales of EE, DP, and PA, was the most frequently reported burnout assessment tool across the primary studies. A few SR/MAs noted the use of other instruments such as the Copenhagen Burnout Inventory or Oldenburg Burnout Inventory. Performance-related outcomes were reported less consistently but included measures of clinical efficiency, documentation time, EHR usability, empathy, and stress. Supplementary Table S1 shows the detailed Physician Specialities, geographic locations, and outcome measures in primary studies of each SR/MA.

The design of primary studies within the SR/MAs was heterogeneous, featuring a mix of RCTs, non-randomized trials, pre-post studies, and observational designs. Some SR/MAs (n = 2) focused predominantly on RCTs, while others incorporated a broader range of methodologies. Qualitative studies were included in a minority of SR/MAs (n = 2) (Supplementary Table S1).

Overview of interventions in included SR/MAs

The interventions described in the SR/MAs to address physician burnout were broadly classifiable as individual-focused or organization-directed, with some reviews

Table 1. *Methodological quality assessment of included systematic reviews using JBI critical appraisal checklist for systematic reviews and research syntheses.*

Checklist item (JBI SR/ RS tool)	Kiratipaisarl et al. [29]	Thomas Craig et al. [9]	Fendel et al. [28]	Tement et al. [22]	Scheepers et al. [27]	De Simone et al. [15]	Wiederhold et al. [20]	Clough et al. [26]	West et al. [6]	Panagioti et al. [19]	Williams et al. [25]	Bazargan-Hejazi et al. [24]	McCray et al. [23]
1. Is the review question clearly and explicitly stated?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2. Were the inclusion criteria appropriate for the review question?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3. Was the search strategy appropriate?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4. Were the sources and resources used to search for studies adequate?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5. Were the criteria for appraising studies appropriate?	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	U	Y	Y
6. Was critical appraisal conducted by two or more reviewers independently?	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	Y
7. Were there methods to minimize errors in data extraction?	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	Y
8. Were the methods used to combine studies appropriate?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9. Was the likelihood of publication bias assessed?	Y	U	Y	U	U	Y	N	N	Y	Y	N	U	Y
10. Were recommendations for policy and/or practice supported by the reported data?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11. Were the specific directives for new research appropriate?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Overall Appraisal (Include/ Exclude/Seek further info)	Include	Include	Include	Include	Include	Include	Seek further info	Include	Include	Include	Seek further info	Include	Include

Y: Yes; N: No; U: Unclear; NA: Not applicable.

Table 2. *Characteristics of included SR/MAs.*

Author (Year)	Objective of SR/MA	Number of primary studies (Total; RCTs)[a]	Total participants in primary studies	Physician career stage(s) covered	Predominant physician specialties covered[b]	Predominant geographic location(s) of primary studies[c]
Kiratipaisarl et al. [29]	To evaluate the effectiveness of individual and organizational interventions in reducing burnout among resident physicians.	33 (11 RCTs)	2,536	Resident physicians	Mixed (10 studies), Pediatrics (4), General surgery (4), Internal medicine (3), Obstetrics/Gynecology (3), and others	Predominantly USA (24 studies); others include Argentina (2), Canada (2)
Thomas Craig et al. [9]	To identify workplace interventions alleviating physician burnout associated with the digital environment, and identify interventions mitigating digital tool burden.	38 (4 RCTs)[d]	NR	Residents and specialists	Primary care physicians/residents (22 studies), Specialists (e.g., radiology, urology) (7), Mixed (4)	Predominantly USA (35 studies); also UK (1), Multinational (2)
Fendel et al. [28]	To quantify the effect size of Mindfulness-Based Interventions in reducing burnout and stress in physicians, and explore potential moderators.	25 (6 RCTs)	925	Practicing physicians (9 studies), Resident physicians (12), Mixed (4)	Mixed specialties (11 studies), General practice (5), Psychiatry (3), Family/Internal medicine (3), Pediatrics (2)	USA (11 studies), Netherlands (5), Spain (4), Australia (2), UK (2)
Tement et al. [22]	To analyze research on PIMs to reduce physician burnout and foster empathy/well-being; assess PIM effects by variables.	18 (4 RCTs)	2,711	Physicians (10 studies), Residents/Interns (8)	Primary care/Family medicine/ General practice (5 studies), Not specified/mixed (3), Intern doctors (2), Residency mixed (3)	USA (11 studies), UK (3), Netherlands (2), Australia (1), Spain (1)
Scheepers et al. [27]	To review and synthesize findings on impacts of Mindfulness-Based Interventions on doctors' well-being and performance.	24 (7 RCTs)	1,275	Residents/trainees (11 studies), Practicing/ Specialists (11), Mixed (2)	General practice/Primary care (6 studies), Mixed (5), Internal medicine (3), Psychiatry (3)	USA (13 studies), Netherlands (5), Spain (2), Australia (2), UK (2)
De Simone et al. [15]	To evaluate if individual- or organization-directed interventions are more effective in reducing physician burnout and provide management suggestions.	19 (19 RCTs)	1,857	Attending/Specialists/GPs (11 studies), Trainees (8)	Primary care/General practice (6 studies), Intensive care (3), Oncology (2), Internal medicine (trainees) (2), General medicine (hospital) (2)	USA (7 studies), Australia (4), Spain (2), Canada (2)
Wiederhold et al. [20]	To review and summarize available studies on interventions for physician burnout.	13 (4 RCTs)	5,330	Practicing physicians (6 studies), Medical residents/Trainees (5)	Oncology (4 studies), Primary care (1), Pediatrics/Med-Peds residents (1), Family medicine (1), Broad "Physicians" (3)	NR

Continued

Author (Year)	Objective of SR/MA	Number of primary studies (Total; RCTs)[a]	Total participants in primary studies	Physician career stage(s) covered	Predominant physician specialties covered[b]	Predominant geographic location(s) of primary studies[c]
Clough et al. [26]	To review evidence on psychosocial interventions reducing occupational stress/ burnout in doctors; assess efficacy by type and research quality.	23 (10 RCTs)	1,273	Junior doctors/Residents (10 studies), GPs/ Specialists (11)	Hospital-based (general) (5 studies), Family practice/Primary care (5), Surgery (residents) (3), Oncology (2), Internal medicine (2)	USA (12 studies), UK (2), Australia (2), Israel (2), Norway (2)
West et al. [6]	To examine interventions to prevent and reduce physician burnout, understanding quality and outcomes.	52 (15 RCTs)	3,630	Resident physicians (26 studies), Practicing physicians (27 studies)[e]	Internal medicine, surgical disciplines, pediatrics, OB/GYN, family medicine, neurology, oncology, multiple specialties (not quantified per specialty)	NR
Panagioti et al. [19]	To evaluate effectiveness of interventions to reduce physician burnout and determine if intervention type, physician experience, or setting impacted effects.	20 (18 RCTs)	1,550	Experienced physicians (≥5 years; 12 studies), Inexperienced (<5 years; 7)	Secondary care (10 studies; e.g., ICU, oncology, surgery), Primary care (7)	USA (8 studies), Europe (4; specific countries not listed in summary), Australia (3), Canada (2)
Williams et al. [25]	To summarize efficacy data of burnout interventions among medical students and residents and how each modality is used.	19 (3 RCTs)[f]	3,108	Medical students (8 studies), Residents/ Interns (11)	Medical students (general) (8 studies), Internal medicine residents (3), Surgical residents/Faculty (3)	Predominantly USA (16 studies); also Norway (1), Australia (1), Belgium (1)
Bazargan-Hejazi et al. [24]	To assess the utility of the PERMA model in reducing physician burnout and improving well-being.	21 (18 RCTs)	7,062	Attending physicians (13 studies), Residents (6), Fellows (1)	Multiple/Mixed (7 studies), Primary care (6), Pediatrics (3), Critical care (2), Internal medicine (2)	USA (8 studies), Spain (3), Australia (3), Canada (2)
McCray et al. [23]	To describe literature on interventions for resident physician burnout (broadened to medical students due to paucity of resident-specific research).	9 (2 RCTs)	710	Residents (6 studies), Medical students (3)	Medical students (3 studies), Internal medicine residents (2), Family med (1), Peds (1), Med-Peds (1), Palliative med (1)	NR

NR = Not Reported by the SR/MA.

[a]For detailed breakdown of primary study designs, see Supplementary Table S1.

[b]For detailed list of physician specialties covered, see Supplementary Table S2.

[c]For detailed list of geographic locations, see Supplementary Table S2.

[d]Thomas Craig et al. [9] (primary study count includes 2 systematic reviews.

[e]For West et al. [6] numbers for career stage refer to the number of studies focusing on that stage.

[f]Williams et al. [25] RCT count includes 2 RCTs and 1 Longitudinal randomized controlled study

examining combinations or specific contexts like the digital environment (Table 3, Supplementary Table S3).

Individual-focused strategies commonly reviewed included mindfulness-based techniques, stress management and resilience training, coaching, cognitive-behavioral approaches, and communication skills training. Organization-directed interventions often involved modifications to work hours and workload, workflow redesign, improvements to the work environment, team-based strategies (including the use of scribes), and EHR optimization (Table 3, Supplementary Table S3).

Delivery formats for these interventions were diverse, ranging from in-person group or individual sessions and workshops to web-based modules, policy changes, and environmental adjustments. Intervention durations varied substantially, from single, brief sessions to programs extending over several months, with some SR/MAs reporting on long-term follow-up assessments (Supplementary Table S3). Comparison groups in the primary studies typically consisted of waitlist controls, no intervention, usual care, or alternative active interventions (Supplementary Table S3).

Reported effectiveness of interventions

Overall, the SR/MAs indicated that interventions can lead to reductions in physician burnout, though effect sizes were often reported as small to moderate (Table 3).

When comparing broad intervention categories, several SR/MAs (n = 3) concluded that organization-directed interventions yielded larger reductions in burnout compared to physician-directed strategies. However, one SR/MA focusing on residents found significant burnout reduction with individual interventions, while organizational interventions showed benefits primarily when targeting the learning environment (Table 3).

Mindfulness-based interventions and psychological interventions with mindfulness elements (PIMs) were reviewed in multiple SR/MAs (n = 4), generally showing positive, though often small, effects on reducing burnout and stress, and sometimes improving empathy. Interventions targeting the digital work environment, particularly multi-component strategies that combined technology optimization with team and workflow changes, were reported by one SR/MA to be more effective than technology-only approaches (Table 3).

Regarding specific burnout dimensions, reductions in EE were commonly reported. Findings for DP n and PA varied, though improvements were noted with certain types of interventions (Table 3). It was also common for SR/MAs to report mixed results or a lack of significant change for some interventions or across different primary studies (Table 3). Some SR/MAs also reported improvements in performance-related outcomes such as clinical efficiency and empathy (Table 3).

Benefits, challenges, and SR/MA conclusions

Beyond direct burnout reduction, interventions were reported in the SR/MAs to offer benefits such as improved physician well-being, stress reduction, and enhanced specific skills (Supplementary Table S4). However, challenges were also frequently highlighted, including the time commitment required for interventions, difficulties in sustaining individual practices, potential negative consequences of some organizational changes, and low participant adherence. The insufficiency of purely individual-focused approaches to address systemic drivers of burnout was a recurring theme (Supplementary Table S4).

The main conclusions from the SR/MAs generally reflected that while various interventions show promise, the evidence base has notable limitations (Table 3, Supplementary Table S5). These limitations, frequently cited by the SR/MA authors, included heterogeneity in primary study designs and interventions, methodological weaknesses in the primary studies (such as high risk of bias, small sample sizes, or short follow-up periods), and an over-reliance on self-reported outcomes. Some SR/MAs also acknowledged their own limitations, such as search scope restrictions or the inability to perform meta-analysis due to the diverse nature of the primary data (Supplementary Table S5).

Consequently, recommendations for future research consistently called for more methodologically rigorous studies, including larger RCTs with long-term follow-up, investigations into combined individual and organizational strategies, and the inclusion of objective outcome measures and cost-effectiveness analyses. For practice and policy, SR/MA authors frequently advocated for a comprehensive approach addressing both individual physician well-being and systemic organizational factors, optimizing the work environment, providing targeted training, and involving physicians in intervention design. A number of SR/MAs specifically suggested that healthcare organizations should prioritize implementing organization-directed strategies (Supplementary Table S5).

Discussion

This umbrella review synthesized evidence from 13 SR/MAs to evaluate interventions for physician burnout. Our main finding is that while a spectrum of strategies can produce statistically significant reductions, the effects are often small to moderate. This conclusion supports the view that burnout is a complicated problem best addressed with a bundled strategy rather than a single solution [21]. Another important finding is that organization-directed interventions tend to yield larger burnout reductions than individual-focused strategies [6,15,19,24].

This central debate over the comparative effectiveness of individualized versus organization-directed interventions is reflected throughout the literature. While several meta-analyses included in our review concluded that organizational strategies were more effective, with some reporting effect sizes more than double those of individual approaches [15,19], this is not a universally settled conclusion. For instance, Kalani et al. [18] reported that different systematic reviews have arrived at conflicting results, likely because many studies fail to account for

Table 3. *Summary of interventions, key outcomes, and conclusions from included SR/MAs.*

Author (Year)	Main intervention categories reviewed by SR/MA	Primary burnout outcome measure(s) used in primary studies (as reported by SR/MA)	Summary of SR/MA findings on burnout outcomes	Summary of SR/MA findings on performance outcomes (if applicable)	Main conclusion(s) of the SR/MA (regarding intervention effectiveness)
Kiratipaisarl et al. [29]	Individual (coaching, meditation); Organizational (work-hour modification, learning environment improvement)	MBI (EE, DP, PA)	Individual: ↓EE (SMD -0.25, $p < 0.01$), ↓DP (SMD -0.17, $p = 0.02$); PA no sig. diff. (SMD 0.18, $p = 0.05$). Org: No sig. association overall; improved learning env. subgroup ↑PA (SMD 0.28, $p = 0.02$).	NR	Individual interventions (coaching, meditation) can reduce EE/DP and improve PA. Organizational interventions targeting learning environment can improve PA. A mixed-bundle approach is favored.
Thomas Craig et al. [9]	Organization-directed (Technology, Time, Teamwork, Transitions) focused on digital environment burden.	MBI, stress, satisfaction	68% of subgroup studies (digital burden focused) reported ↓burnout/stress or ↑satisfaction. Teamwork, Time, Transitions interventions (often combined) (85-90% improve) > Technology-only (41% improve).	Improved clinical efficiency/productivity (scribes); ↓documentation time (scribes, templates); ↓interruptions; improved scheduling; enhanced EHR usability/satisfaction with optimization/training.	Burnout from digital environment can be mitigated by combined technology/workflow optimization, training, team expansion, not by tech implementation alone.
Fendel et al. [28]	Mindfulness-Based Interventions (e.g., MBSR, MBST, online apps)	MBI-HSS, CBI, aMBI, OLBI, BCSQ	MBIs associated with small sig. ↓burnout (RCTs: SMD -0.26; All studies pre-post: SMD -0.26). Reductions maintained at follow-up (avg. 5.3 months).	NR (Focus on burnout and stress)	MBIs can be effective in reducing physician burnout and stress; however, higher quality trials are needed.
Tement et al. [22]	PIMs (e.g., MBSR, mindfulness training, discussion groups, SMART, mobile apps)	MBI	PIMs generally positive impact on ↓burnout. Physicians: MBI studies showed sig./substantial improvement in ≥1 subscale. Residents: Only positive non-sig. trends for MBI. Sustained effects observed.	PIMs generally positive impact on ↑empathy (JSE) and ↓stress (PSS).	PIMs positively impact empathy, well-being, and burnout reduction in physicians. Mobile app interventions show potential. Peer support/group participation and mindfulness training highlighted.
Scheepers et al. [27]	Mindfulness-Based Interventions (group-based, web/smartphone-based)	Burnout questionnaires (MBI implied), well-being measures (job satisfaction, etc.)	Group-based MBIs generally showed positive effects on well-being (↓burnout, ↑job satisfaction, etc.). Web-based MBIs showed mixed/limited effects on ↓burnout.	Performance improved in interpersonal domains (↑empathy, psychosocial orientation). Mixed results for safety (no effect on self-reported medical errors in MBSR/MBCT; one MBI study ↑hand hygiene).	Doctors perceive positive impacts of MBIs on well-being/performance, but evidence has methodological limitations. Group-based MBIs could be offered as voluntary modules.
De Simone et al. [15]	Physician-directed (mindfulness, education, exercise); Organization-directed (workload, teamwork, structural changes)	MBI	Overall: Small sig. ↓burnout (SMD -0.289). Organization-directed: Medium ↓burnout (SMD -0.446) > Physician-directed: Moderate, smaller ↓burnout (SMD -0.178). Org-directed: greater ↓DP & ↑PA.	NR	Both intervention types reduce burnout. Organization-directed interventions are more effective overall and for DP/PA dimensions. Burnout is rooted in work environment/organizational culture.

Continued

Author (Year)	Main intervention categories reviewed by SR/MA	Primary burnout outcome measure(s) used in primary studies (as reported by SR/MA)	Summary of SR/MA findings on burnout outcomes	Summary of SR/MA findings on performance outcomes (if applicable)	Main conclusion(s) of the SR/MA (regarding intervention effectiveness)
Wiederhold et a. [20]	Organization-directed (task restructure, work hours, leadership); Individual-directed (CBT, stress mgmt, counseling, mindfulness)	MBI	Mixed results. Some interventions (art therapy+CBT, mindful communication, stress mgmt workshops, ROM, some team/ counseling) ↓aspects of burnout. Several others (some communication skills) showed no sig. ↓burnout.	NR	Spectrum of interventions is diverse and fragmented; robust evidence for specific solutions limited. Effective interventions likely need to address multiple causes and integrate multiple tools.
Clough et al. [26]	Psychosocial interventions (Cognitive-behavioural, Relaxation/attention training, Discussion/ support)	MBI	Cognitive-behavioural: Small to medium ↓burnout (some studies no sig. change/worsening). Relaxation/ Attention: Some reported sig. ↓EE. Discussion/Support: Generally no sig. effects on burnout, some trended worse.	NR (Stress was an outcome, CBT showed most robust evidence for ↓stress)	Research quality is generally low. Cognitive-behavioural interventions show most promise for ↓stress and some for ↓burnout. Discussion/ support groups lack evidence of efficacy.
West et al. [6]	Individual-focused (small groups, stress mgmt, communication, mindfulness); Structural/ Organizational (rotation length, work processes, duty hours)	MBI	Overall ↓burnout (54% to 44%). ↓EE score (mean 2.65 pts), ↓DP score (mean 0.64 pts). ↓High EE (38% to 24%), ↓High DP (38% to 34%). Structural/Organizational > Individual-focused for ↓overall burnout.	NR	Both individual-focused and structural/organizational strategies can lead to clinically meaningful reductions in physician burnout.
Panagioti et al. [19]	Physician-directed (mindfulness, education, exercise); Organization-directed (workload, teamwork, structural changes)	MBI	Overall: Small sig. ↓burnout (SMD -0.29; ~3 pt drop on MBI EE). Organization-directed: Larger effect (SMD -0.45) > Physician-directed (SMD -0.18). Also very small ↓DP & small ↑PA.	NR	Interventions show small, significant benefits. Organization-directed approaches may boost benefits, supporting view that burnout is an organizational problem.
Williams et al. [25]	Duty-hour restrictions, Communication skills, Mindfulness, Pass-Fail grading, ROM, Balint groups, Journaling, Stress Mgmt, BATHE, Comprehensive approach	MBI	Mixed results. Benefits for ↓burnout from: Pass-fail grading, Mindfulness (some studies), ROM (↓EE), Self-development groups (↓stress). Duty-hours: mixed. No clear benefit: Communication skills, Balint, Journaling, singular Stress Mgmt, BATHE.	NR	A growing body of evidence for interventions (pass-fail grading, mindfulness, ROM, self-development groups, some duty-hour aspects) exists to mitigate burnout in medical education.
Bazargan-Hejazi et al. [24]	Physician-directed (mindfulness, group activities, team-based); System-directed (work hours, staffing, workload)	NR (Burnout/well-being measures implied)	Majority reported some positive outcome. Of 10 studies with sig. favorable outcomes: 6 system-directed, 4 physician-directed. 11 studies no sig. results. Overall: "more favorable outcomes in system-directed intervention."	NR	System-directed interventions produced more favorable results in reducing burnout/improving well-being than physician-directed. PERMA model utility largely unaddressed in existing literature.

Continued

Author (Year)	Main intervention categories reviewed by SR/MA	Primary burnout outcome measure(s) used in primary studies (as reported by SR/MA)	Summary of SR/MA findings on burnout outcomes	Summary of SR/MA findings on performance outcomes (if applicable)	Main conclusion(s) of the SR/MA (regarding intervention effectiveness)
McCray et al. [23]	Workshops (team training, stress mgmt), Resident Assistance Prog., Self-care, Support groups, Didactic sessions, ROM, Mindfulness course	MBI	Some positive impact from: Team training (↑Personal Orientation), Stress mgmt workshop (↓EE), ROM (↓EE), Mindfulness course (↓mood disturbance). Self-care (medical students): some sleep hygiene impr., no diff. alcohol/depression. Support group (students): no measurable effect.	Improved scores on Personal Orientation Inventory (team training); ↓total mood disturbance (mindfulness).	Few interventions exist for resident burnout. Some (team training, stress mgmt workshop, ROM, mindfulness) show positive impact. Prospective, controlled studies are needed.

MBI = Maslach Burnout Inventory; EE = Emotional Exhaustion; DP = Depersonalization; PA = Personal Accomplishment; SMD = Standardized Mean Difference; sig. = significant; Org = Organizational; Indiv = Individual; NR = Not Reported by SR/MA; RCT = Randomized Controlled Trial; SR = Systematic Review; MA = Meta-Analysis; MBSR = Mindfulness-Based Stress Reduction; MBST = Mind-Body Skills Training; OLBI = Oldenburg Burnout Inventory; BCSQ = Burnout Clinical Subtype Questionnaire; CBI = Copenhagen Burnout Inventory; PIMs = Psychological Interventions with elements of Mindfulness; JSE = Jefferson Scale for Physician Empathy; PSS = Perceived Stress Scale; SMART = Stress Management and Resilience Training; ROM = Respiratory One Method; BATHE = Background, Affect, Trouble, Handling, Empathy (psychotherapeutic technique); PERMA = Positive emotion, Engagement, Relationships, Meaning, Achievements. CBT = Cognitive Behavioral Therapy. ↓ = decrease/reduction; ↑ = increase/improvement.

the mediating and moderating variables that influence an intervention's true effectiveness. One of the most significant weaknesses contributing to this inconsistency is the tendency within the research to treat physicians as a single homogeneous population. Interventions are often analyzed collectively across medical students, residents, and experienced specialists, yet these groups face vastly different stressors and likely require different types of support [18]. Furthermore, individual differences such as age, specialty, and even personality traits are known to influence burnout susceptibility but are rarely considered as moderators in intervention studies [33–37].

The theoretical rationale for why certain interventions work also provides crucial context. Previous studies propose a model where resilience acts as a bridge from burnout to wellness [38,39]. Their effectiveness can be understood through the theory of coping, which involves cognitive and behavioral efforts to manage taxing demands [40], and emotional intelligence theory, which underpins the development of emotion regulation skills [41].

The primary strength of this umbrella review lies in its comprehensive and updated synthesis of this broad and complex body of secondary evidence. However, this review has inherent limitations that mirror the weaknesses of the literature it synthesizes. Its conclusions are contingent upon the quality and scope of the included SR/MAs and their primary studies. The likely overlap of these primary studies across the reviews is a significant limitation that can lead to an overemphasis on the findings of certain influential trials. Furthermore, due to the substantial heterogeneity across the SR/MAs, we were unable to conduct a quantitative meta-synthesis, relying instead on a narrative summary, which lacks the statistical power of a pooled analysis.

Conclusion

In conclusion, this umbrella review confirms that interventions can successfully reduce physician burnout, but their effectiveness varies significantly. The weight of the evidence indicates that organization-directed strategies that address systemic issues in the work environment are more impactful than interventions focused solely on individual physicians. However, burnout is an occupational phenomenon arising from the complex interaction between a demanding work environment and an individual's capacity to cope. Therefore, the most promising path forward is a bundled strategy that prioritizes fixing the workplace while simultaneously supporting the individual. To make meaningful and sustainable progress, healthcare organizations must commit to implementing comprehensive, system-level changes that create healthier and more efficient clinical environments.

List of Abbreviations

emotional exhaustion (EE), depersonalization (DP) personal accomplishment (PA) health records (EHRs)

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Supplementary Table S1. *Detailed physician specialties, geographic locations, and outcome measures in primary studies of each SR/MA.*

Author (Year)	Detailed list of physician specialties covered	Detailed list of geographic locations of primary studies	Burnout scales listed	Performance-related outcome scales/Metrics listed
Kiratipaisarl et al. [29]	Mixed (10 studies), Pediatrics (4), General surgery (4), Internal medicine (3), Obstetrics and gynecology (3), Neurosurgery (2), Emergency medicine (2), Otolaryngology (2), Anesthesiology (1), Cardiology (1), Neurology (1)	United States (24 studies), Argentina (2), Canada (2), Belgium (1), China (1), Philippines (1), United Kingdom (1), Netherlands (1)	Maslach burnout inventory (MBI) for emotional exhaustion (EE), depersonalization (DP), and personal accomplishment (PA)	NR
Thomas Craig et al. [9]	Primary care physicians (and residents) (22 studies), Specialists (e.g., radiologists, ophthalmologists, urologists, neuroradiologists) (7), Mix of primary care and specialists (4), Unspecified specialties (5)	USA (35 studies), United Kingdom (1), Multinational (2)	MBI	Metrics related to informatics usability, effectiveness, and impact (e.g., time and motion studies measuring task completion/ documentation time, efficiency, productivity). Specific standardized scales not uniformly listed.
Fendel et al. [28]	General practice (5 studies), Psychiatry (3), Pediatrics (2), Family or internal medicine (3), Surgery (1), Mixed specialties (11)	United States (11 studies), Netherlands (5), Spain (4), Australia (2), United Kingdom (2), Germany (1)	Maslach burnout inventory-human services survey, Copenhagen burnout inventory (work-related burnout), Abbreviated Maslach burnout Inventory, oldenburg burnout Inventory, burnout clinical Subtype questionnaire	NR
Tement et al. [22]	Primary care/Family medicine/General practice (5 studies), Internal medicine (1), Radiology (1), Not specified/mixed (3), Intern doctors (2), Residency mixed (3), Pediatric residents (1), Psychiatry residents (1), Family medicine residents (1)	USA (11 studies), United Kingdom (3), The Netherlands (2), Australia (1), Spain (1)	MBI	Perceived stress scale (PSS), Jefferson scale for physician empathy (JSE), Five facet mindfulness questionnaire (FFMQ)
Scheepers et al. [27]	General practice/Primary care (including Family medicine as primary focus) (6 studies), Internal medicine (3), Psychiatry (3), Mixed (5), Unspecified/Not reported (3), Emergency medicine (1), Radiology (1), Surgery (1), Pediatrics (1)	United States (13 studies), The Netherlands (5), Spain (2), Australia (2), United Kingdom (2)	Questionnaires on burnout, empowerment at work, job satisfaction, specialty satisfaction, work engagement (MBI implied as primary burnout tool)	Measures of empathy, psychosocial orientation, self-reported medical errors, hand hygiene.
De Simone et al. [15]	Primary Care/General practice (6 studies), Intensive Care (3), Oncology/Cancer Units (2), Internal medicine (primarily trainees) (2), General medicine (distinct from primary care, often hospital-based) (2), Pediatrics (trainees) (1), Mixed/Various specialties (3)	USA (7 studies), Australia (4), Spain (2), Canada (2), Belgium (1), Israel (1), Argentina (1), The Netherlands (1)	MBI	NR

Continued

Author (Year)	Detailed list of physician specialties covered	Detailed list of geographic locations of primary studies	Burnout scales listed	Performance-related outcome scales/Metrics listed
Wiederhold et al. [20]	Oncology (oncology medical residents, oncologists, operators of oncology centers, oncology wards) (4 studies), Primary care physicians (1), Pediatrics and medicine-pediatrics residents (1), Family medicine physicians (1), Broad "Physicians" (unspecified, or for leadership/professional effort studies) (3), Medical house officers (1), "Doctors" (for counseling intervention) (1), Physician trainees (for exercise program) (1)	NR	MBI	NR
Clough et al. [26]	Family practice/Primary care (5 studies), Surgery (novice surgeons, surgical residents) (3), Oncology (medical residents, oncologists) (2), Obstetrics and Gynaecology (residents) (1), Internal medicine (physicians) (2), Radiology (physicians) (1), Pediatrics (house officers) (1), Hospital-based physicians (general) (5), Doctors from a range of specialties (via national programs) (2)	USA (12 studies), UK (2), Australia (2), Israel (2), Norway (2), Belgium (1), Canada (1), Egypt (1)	MBI	NR (focus was on stress and burnout)
West et al. [6]	Internal medicine, surgical disciplines, pediatrics, obstetrics and gynaecology, family medicine, neurology, oncology, multiple specialties	NR	MBI	NR
Panagioti et al. [19]	Primary care (mostly "general practitioners") (7 studies), Secondary care (e.g., physicians in intensive care units, oncologists, surgeons) (10), Mixed sample (from national medical associations) (2)	United States (8 studies), Europe (4 studies - specific countries not detailed in SR summary), Australia (3), Canada (2), Argentina (1)	MBI	NR
Williams et al. [25]	Internal medicine residents (3 studies), Surgical residents/Faculty (various surgical specialties including orthopedic) (3), Family medicine residents (1), Pediatric residents (1), OB/Gyn residents (1), Medical oncology residents (1), Medical students (general, not specialty specific) (8), Residents (unspecified/multiple specialties) (1)	USA (16 studies), Norway (1), Australia (1), Belgium (1)	MBI	NR (POMS mentioned for a study, which overlaps with burnout, but not as a primary performance outcome in the SR's summary)
Bazargan-Hejazi et al. [24]	Primary care (6 studies), Critical care (2), Pediatrics (3), Oncology (1), Multiple/Mixed (7), Internal medicine (2)	USA (8 studies), Spain (3), Australia (3), Canada (2), Belgium (1), Israel (1), Argentina (1), Netherlands (1)	NR (Implied MBI or similar standard burnout measures were used based on intervention outcomes reported)	NR
McCray et al. [23]	Family medicine residents (1 study), Internal medicine residents (2), Pediatric residents (1), Medicine-pediatric residents (1), Palliative medicine (1), Medical students (3), Residents (general, not specialty specific) (1)	NR	NR	NR

NR = Not Reported by the SR/MA.

Supplementary Table S2. *Detailed breakdown of primary study designs in each SR/MA.*

Author (Year)	Total primary studies	No. of RCTs	No. of non-randomised controlled trials (CTs)	No. of pre-post studies	No. of qualitative studies	Other study types
Kiratipaisarl et al. [29]	33	11	9 (historical control studies)	13 (self-control studies)	0	-
Thomas Craig et al. [9]	38	4	0	21 (pre-post-intervention surveys)	0	4 Cross-sectional studies, 5 Prospective studies, 2 systematic reviews, 2 Other designs
Fendel et al. [28]	25	6	19 (nonrandomised trials)	0 (NRTs likely include pre-post elements but not distinctly categorized)	0	-
Tement et al. [22]	18	4	1	8	2	3 Mixed method pre-post intervention studies
Scheepers et al. [27]	24	7	3	12	2	-
De Simone et al. [15]	19	19	0	0	0	-
Wiederhold et al. [20]	13	4	4	1	0	1 Noncontrolled prospective study, 1 Cohort study, 1 Correlational study, 1 Longitudinal Assessment
Clough et al. [26]	23	10	5	8	0	-
West et al. [6]	52	15	0 (categorized as cohort studies)	0 (categorized as cohort studies)	0	37 cohort studies
Panagioti et al. [19]	20	18	2	0	0	-
Williams et al. [25]	19	2	8	5 (Nonrandomized uncontrolled)	0	3 Longitudinal nonrandomized uncontrolled, 1 Longitudinal randomized controlled
Bazargan-Hejazi et al. [24]	21	18	3 (Non-randomized studies)	0	0	-
McCray et al. [23]	9	2	3	1	0	3 Longitudinal cohort study

RCT: Randomized Controlled Trial; NRT: Non-Randomized Trial.

Supplementary Table S3. *Detailed summary of intervention types, delivery formats, durations, and comparison groups from each SR/MA.*

Author (Year)	Types of interventions described (detailed summary from SR/MA)	Intervention delivery format(s) summarized	Intervention duration/ Length summarized	Comparison groups in primary studies (as summarized by SR/ MA)
Kiratipaisarl et al. [29]	Individual (25 studies): 16 (64%) coaching-centered (self-development, resilience, coping); 9 (36%) exclusively meditation. Examples: wellness lecture, communication/ stress management skills, online group-coaching, Balint group, psychotherapeutic tool (BATHE), Professional Development Coaching, Resilience coaching, Smartphone meditation, Attention-based training, Mindfulness course (MAPS). Organizational (8 studies): 6 (75%) work-hour modification (shift lengths, rest days); 2 (25%) improved learning environment (healthy food, workflow modifications).	Individual-focused: Individual coaching, smartphone meditation apps, individual psychotherapeutic toll. Group-based: Lectures, workshops (communication, stress management, resilience), Balint groups, group coaching, mindfulness courses (MBSR, Yoga-based), wellness programs. Organizational-level: Policy changes (work hours, rest days, protected time), environmental changes (food delivery, workflow).	Median timeframe of interventions is 6 months.	"Waitlist control," "Pre-intervention, previous academic year" (historical control), "Pre-intervention baseline characteristics of the participants" (self-control/pre-post).
Thomas Craig et al. [9]	Organization-directed workplace interventions (digital environment focus, "4Ts framework"): Technology: EHR implementation/improvement, patient portals, decision support, CPOE, EHR-integrated paging, clinical task-management systems (adoption, implementation, optimization). Time: Duty hour restrictions, schedule changes, shifting clerical tasks. Teamwork: Care team process examination, addition of scribes/medical assistants for HIT documentation. Transitions: Process improvements, QI initiatives (workflow, lean).	Technology: EHR customization, new software implementation, user training, speech recognition, decision support. Time: Schedule modifications, task delegation. Teamwork: Scribes/medical assistants for documentation, team huddles, changed team responsibilities, co-location. Transitions: Workflow redesign, QI initiatives, lean methodology.	NR	Majority provided baseline/pre-intervention data. Others: standard (non-enhanced) technologies, paper charting, no intervention, crossover periods without intervention.
Fendel et al. [28]	Adapted MBSR (10 studies), Standard MBSR (4), Mind-body skills training (MBST) (2), Online mindfulness app (Headspace) (2), Adapted MBCT (1), Other MBIs (6).	Face-to-face (18 studies: 6 RCTs, 12 NRTs), Web-based (2), Mixed (offline/online) (5).	Varied: 2 days focused face-to-face to 3 months online/in-person. Majority 2-3 month (8-10 weekly sessions). Avg. guided treatment: 18.8 hours (RCTs), 16.1 hour (NRTs); Overall avg: 16.8 hours. Individual practice: 3 studies reported avg. 18 minutes.	RCTs: Waitlist (4), active control (e.g., psychoeducation, extra break) (2). NRTs: nonactive control or no control group.
Tement et al. [22]	MBSR (3 studies, 8 weeks), Mindfulness training (non-MBSR) (8 studies, 18 hour-10 week), Discussion groups (2 studies, 6-9 months), Stress management & resilience training (SMART) (1 study, 90 minutes), "Art of Seeing" course (1 study, 4 weeks), Wellness curriculum (1 study, 1 month), Mindfulness via smartphone app (2 studies, 10 days/4 weeks).	In-person (group-based, individual components), Online/Mobile application-based, Combination of in-person and online.	90 minutes (SMART), 8 weeks (MBSR), up to 10 weeks (other mindfulness), 6-9 month (discussion groups).	RCTs and non-randomized controlled trials used a control group. Other designs were pre-post or qualitative.

Continued

Author (Year)	Types of interventions described (detailed summary from SR/MA)	Intervention delivery format(s) summarized	Intervention duration/ Length summarized	Comparison groups in primary studies (as summarized by SR/ MA)
Scheepers et al. [27]	Mindfulness-based interventions (MBIs) adopting a mindfulness approach to train 'purposeful and non-judgemental attention to present experiences, thoughts and feelings'.	Primarily group-based training (21 studies). Some web-based/smartphone-based approaches (3 studies).	Short-term (single-session, 10-minute video, 90-minute session, 2-day retreats). Medium-term (most common, 2-3 month weekly sessions). Long-term (one 9-month program). Some included maintenance phases (e.g., 10-month).	Waitlist control, passive control conditions, or exposure to protected free time.
De Simone et al. [15]	Physician-directed: Mindfulness-based stress reduction, educational programs (self-confidence, communication skills), exercise programs (sometimes combined). Organization-directed: Workload modifications (rescheduling shifts, reducing workload), discussion meetings (teamwork, leadership), structural changes, communication skills training, mindfulness as organizational initiative.	Workshops, specific training sessions, policy changes (scheduling, workload), structured team meetings.	Ranged from 2 weeks to 9 months.	NR (Implicitly control groups for RCTs)
Wiederhold et al. [20]	Organization-directed: Task restructuring, work evaluation, supervision changes, work-hour reductions, social support enhancement, organizational leadership programs, changes in professional effort. Individual-directed: CBT, stress management, communication skills, counseling, mindful communication, self-administered psychotherapeutic tools, respiratory one method (ROM), incentivized exercise programs.	Workshops (half-day to multi-day), group meetings, individual counseling, team-based programs, educational lectures, role-plays, data-guided programs, leadership training, policy changes (work hours).	Variations like 12-week programs, short workshops, and longitudinal assessments.	NR (Implied control groups for RCTs and some non-RCTs)
Clough et al. [26]	Cognitive-behavioural (17 studies): Promote coping, stress management, mindfulness, communication, cognitive reappraisal. Relaxation/attention training (3 studies): Mental imagery, biofeedback, breathing-focused relaxation. Discussion/support (3 studies + 1 comparator): Unstructured support/discussion (Balint groups, workplace debriefing).	All interventions delivered in person.	Total duration varied from 45 minutes to approximately 60 hours.	RCTs (10) and quasi-experimental (5) involved comparison groups. 4 used active controls; rest used passive waitlist. 8 were single group pre-post.
West et al. [6]	Individual-focused (RCTs): Facilitated small group curricula, stress management/self-care training, communication skills, "belonging intervention." Individual-focused (Cohorts): Facilitated/non-facilitated small groups, stress/self-care, communication, mindfulness. Structural/Organizational (RCTs): Shortened attending rotation, work process modifications, shortened resident shifts. Structural/Organizational (Cohorts): US duty hour requirements, practice delivery changes.	Small group discussions, specific training programs, policy-driven changes (duty hours), modifications to clinical work processes.	RCTs: follow-up 19 weeks to ~4 years. Cohorts: follow-up 1 month to 2 years. (SR/MA does not summarize initial intervention durations themselves).	NR (Implicitly control groups for RCTs and comparison groups for cohorts)

Continued

Author (Year)	Types of interventions described (detailed summary from SR/MA)	Intervention delivery format(s) summarized	Intervention duration/ Length summarized	Comparison groups in primary studies (as summarized by SR/ MA)
Panagioti et al. [19]	Physician-directed (12 comparisons): MBSR, educational interventions (self-confidence, communication skills), exercise, or combination. Organization-directed (8 comparisons): Simple workload interventions (5 studies: rescheduling shifts, reducing workload); More extensive org-directed (3 studies: discussion meetings for teamwork/leadership, structural changes, elements of physician interventions like communication skills/mindfulness).	All interventions delivered in face-to-face format.	Ranged from 2 weeks to 9 months.	Waiting list or no intervention.
Williams et al. [25]	ACGME duty-hour restrictions (2003) (6 studies), communication skills course (1), Mindfulness meditation/ Training (MBSR, Mind-body skills, guided meditation) (3), Pass-fail grading dystem (2), Respiratory one method (ROM) (1), Balint groups (1), Journaling (1), Self-development groups (1), Stress management training/ Workshop (2), BATHE psychotherapeutic technique (1), Comprehensive approach (Counseling, Education, Awareness) (1).	Policy changes (duty hours), educational courses/ workshops (mindfulness, communication, stress management), group sessions (Balint, self-development), individual techniques (ROM, journaling, BATHE), systemic changes (pass-fail grading).	Durations included 10-week courses, 4-hour workshops, ongoing duty-hour policies.	Wait-list control, different active interventions, pre-post comparisons, comparisons with non-compliant groups (duty hours), or upperclassmen (pass-fail grading).
Bazargan-Hejazi et al. [24]	Physician-directed (13 studies): Mindfulness exercises, group activities (debriefing, discussions), team-based approaches. Some individualized (self-care, communication skill training). System-directed (8 studies): Targeted work hour schedules, staffing, workload reduction. One study combined physician and system-directed elements.	Mindfulness training, psycho-educational programs, workshops (coping/mindfulness), discussion groups, debriefing sessions, self-directed micro-tasks, changes to workload/schedule (weekend breaks, shift rotations), team-based exercise, self-care workshops.	Varying durations.	Waiting list, no intervention, usual care, or alternative intervention. 3 studies had non-randomized designs (e.g., controlled before-after).
McCray et al. [23]	Workshops (Team training, day-long stress management), Resident assistance program (RAP), Self-care intervention (medical students: lectures, info, group discussion), Support Groups (junior doctors palliative care, medical students), Didactic sessions/Professional development program (IM residents: open discussion, problem-solving), Stress-management/Coping training, Respiratory-one method (ROM), mindfulness-based meditation course (10 sessions).	Group-based formats common (workshops, support groups, MBSR, professional development). Some individual (self-care, ROM).	Nine weekly workshops, ongoing RAP, 3-week support group, 11 sessions for professional development, single day-long workshop, 10-session mindfulness course.	NR (Implicitly control groups for RCTs and some non-RCTs, pre-post for others)

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Supplementary Table S4. *Reported benefits and challenges/Barriers of interventions from each SR/MA.*

Author (Year)	Reported benefits of interventions (as summarized by SR/MA)	Reported challenges/Barriers of interventions (as summarized by SR/MA)
Kiratipaisarl et al. [29]	Individual interventions: significantly associated with reduced EE and DP. Individual coaching: statistically significant reduction in EE. Individual meditation: statistically significant improvement in PA. Organizational interventions (learning environment): improvement in PA scores.	Work hour modifications could disrupt patient care continuity/handovers. Mandatory organizational changes might be viewed unfavorably if perceived as impinging on resident autonomy.
Thomas Craig et al. [9]	Burnout decreased by: technology optimization (EHRs), training, reduced documentation/task time, care team expansion (scribes), QI in workflows. Scribes: ↓documentation burden, ↑efficiency, ↑physician satisfaction. Process improvements (QI, lean) + workflow redesign: ↓burnout. Tailored EHRs/usability improvements: ↓burnout.	Simple tech implementation alone may worsen burnout. Generic EHRs inadequately meet specialty needs. Documentation burden (regulatory/billing) is substantial low-value work. Information overload. Steep learning curve for complex tech.
Fendel et al. [28]	MBIs associated with significant small reductions in physician burnout and medium (between-group)/small (pre-post) reductions in stress. Effects maintained at follow-up. Established MBIs (MBSR, MBST, adapted MBSR/MBCT) showed higher effectiveness in reducing stress than other MBI forms or mindfulness apps.	NR (Focus on effectiveness; limitations section implies challenges related to study quality and unreported home practice)
Tement et al. [22]	PIMs generally positive impact on ↓burnout, ↑empathy, ↑well-being. MBSR, other mindfulness training, discussion groups effective. Mobile app interventions show potential. Sustained effects observed. Peer support/group participation and mindfulness training highlighted as having "healing power."	NR (Methodological limitations of primary studies are discussed, implying challenges in demonstrating efficacy robustly rather than intervention-specific barriers)
Scheepers et al. [27]	Doctors generally perceived positive impacts from MBIs on well-being/performance. Benefits: enhanced self-understanding, understanding of others, peer support (group formats). Medium-term group-based MBIs positively affected well-being (↓burnout, ↑job satisfaction, ↑dedication) and performance (↑empathy).	Time limitations for practice and feasibility of sustaining daily practice due to high workloads. Web-based MBIs showed mixed/limited effects on negative well-being indicators like burnout.
De Simone et al. [15]	Both physician-directed and organization-directed interventions led to statistically significant reductions in physician burnout. Organization-directed interventions demonstrated a larger overall effect size and were more impactful in improving DP and PA dimensions.	NR (Focus on comparative effectiveness; limitations section implies challenges related to diagnostic tools and setting generalizability)
Wiederhold et al. [20]	Successful interventions (art therapy+CBT, mindful communication, stress management workshops, ROM, some team/counseling programs) showed some effectiveness in ↓aspects of physician burnout. Organizational factors (leadership, professional effort) influenced physician well-being.	Many studies lacked randomized controls. Some communication skills training ineffective (hypothesized due to low baseline burnout or disconnect with burnout mechanisms). Person-directed interventions alone may be insufficient due to multifactorial nature of burnout.
Clough et al. [26]	Cognitive-behavioural interventions showed most robust evidence for ↓stress, and some promise for ↓burnout. Some evidence for relaxation-based approaches (primarily for ↓stress).	Discussion/support groups (e.g., Balint) did not show evidence of efficacy. Lack of detail in primary studies on promoting engagement/adherence. Low participant adherence in several studies.
West et al. [6]	Both individual-focused (mindfulness, stress management, small groups) and structural/organizational strategies (duty hour modifications, changes to work processes) can lead to clinically meaningful reductions in burnout.	Combined effect of individual and structural/organizational approaches not studied. Unknown which interventions most effective for particular populations. Long-term sustainability of effects poorly understood.
Panagioti et al. [19]	Intervention programs associated with small, but statistically significant, benefits for ↓burnout. Organization-directed approaches may boost these benefits (larger effect sizes than physician-directed).	Physician-directed interventions (more common) led to only very small significant reductions in burnout. Intense organization-directed interventions were rare and not widely evaluated.

Continued

Author (Year)	Reported benefits of interventions (as summarized by SR/MA)	Reported challenges/Barriers of interventions (as summarized by SR/MA)
Williams et al. [25]	Pass-fail grading, mindfulness training, ROM, self-development groups, and some aspects of 2003 ACGME duty-hour limitations demonstrated benefit in ↓burnout in at least one study.	Many studies had small sample sizes. Resident duty-hour studies: mixed results, some negative impacts on educational perceptions or no change in MBI domains. Some individual-focused interventions (singular stress mgmt, Balint, journaling, communication skills, BATHE) showed no clear benefit.
Bazargan-Hejazi et al. [24]	System-directed interventions produced more favorable results in ↓burnout or ↑well-being. Interventions with PERMA-resonant strategies (mindfulness for positive emotion; strategies for meaning, engagement, relationships) showed positive outcomes in several studies. Most studies showed some positive outcomes.	Except for one study (bio-psychosocial approach), none of the interventions were explicitly based on a conceptual model like PERMA.
McCray et al. [23]	Team training workshops (↑Personal Orientation Inventory), day-long stress management workshop (↓EE), ROM (↓EE), mindfulness-based meditation course (↓mood disturbance) showed some positive impact.	Paucity of intervention research for resident/student burnout. Many studies small, non-randomized. Interventions often lacked manualization/detailed descriptions (hindering replicability). Few used validated burnout measures.

Supplementary Table S5. *Limitations of SR/MAs and Authors' recommendations.*

Author (Year)	Limitations of the SR/MA (as stated by its authors)	SR/MA Authors' recommendations for future research	SR/MA authors' recommendations for practice/Policy
Kiratipaisarl et al. et al. [29]	Search Scope (MBI only). Heterogeneity (diverse interventions, controls, populations, methodologies). Risk of Bias (high in primary studies). Organizational Interventions (insufficient number/variety).	Prioritize studies on combined individual/organizational interventions with rigorous methodologies. Employ robust designs (preference-based trials, cluster RCTs, stepped-wedge RCTs, well-controlled non-randomized studies).	Consider individual coaching (± meditation) to ↓EE, ↑PA. Suggested Dosing (Individual): 1-2 hour/session, 1-2 x/month, 6-12 month. Evaluate org work-hour changes after 2-4 month; complex learning env. interventions over 1-2 year. Emphasize participant compliance. Favor mixed-bundle approach (individual + organizational).
Thomas Craig et al. [9]	Heterogeneity (prevented meta-analysis). Physician-specific focus. Generalizability (mostly US primary care). Study quality (predominance of low-quality, short follow-up). Abstracted details (some conference abstracts). Outcome reporting (many lacked statistical analyses/used qualitative burnout findings).	More research on digital tools (esp. advanced analytics/AI) impact on burnout for various clinicians. Rigorously evaluate digital tool usability & direct effect on burnout. Investigate interventions targeting information overload & improving interoperability.	Optimize tech (EHRs) for usability/specialty needs. Provide comprehensive, timed training. Redesign workflows, expand care teams (scribes) to shift documentation burden. Leverage QI/lean. Consider broader ecosystem (organization, marketplace, regulatory policies). Advocate for regulatory changes to ↓documentation burden.
Fendel et al. [28]	Limited RCTs. Unreported home practice. Few long-term follow-ups. Risk of bias (high for NRTs). Evidence quality (low to very low).	Conduct high-quality studies (larger samples, controlled trials, long-term follow-up) to confirm results, determine optimal MBI components/lengths.	Healthcare policymakers: consider implementing mindfulness in medical education. Institutions & physicians: be involved in improving physician well-being. MBI programs: present as opportunities for well-being/meaning, not just to mitigate burnout/stress.

Continued

Author (Year)	Limitations of the SR/MA (as stated by its authors)	SR/MA Authors' recommendations for future research	SR/MA authors' recommendations for practice/Policy
Tement et al. [22]	Methodological quality (some studies weak designs, small samples). Generalizability (varied instruments, durations, samples). Risk of bias (some substantial). Self-reported outcomes. Insufficient intervention descriptions.	Upgrade self-reported data with objective physiological measures or combine subjective/objective. Future studies: well-planned, rigorous, uniform design. Address which intervention offers more benefits. Future RCTs (larger N): address optimal approaches to development/ implementation (feasibility, costs). Investigate long-term impact, cost-effectiveness. Consider periodic re-exposure/refreshers.	Serve as awareness-raising for feasible interventions. Encourage mindfulness/discussion groups in resident/trainee programs. Recognize "healing power" of peer support/group participation & mindfulness.
Scheepers et al. [27]	Average methodological quality of primary studies. Frequent self-selection. Lack of placebo. Reliance on self-reported outcomes. Heterogeneity (precluded meta-analysis). Potential publication bias.	Conduct RCTs estimating selection bias, using placebo. Use mixed methods. Tailor MBIs. Research MBI effects on physical well-being, patient-reported outcomes, safety. Foster international collaborations for optimal MBI designs.	Offer group-based MBIs as voluntary modules. Combine MBIs with organizational changes. Address time/feasibility. Consider MBIs in medical school curricula.
De Simone et al. [15]	Search scope (MBI only). setting generalizability (predominantly acute care).	Future research should focus on identifying the most effective approaches for the development and implementation of organizational interventions aimed at reducing physician burnout.	Healthcare organizations should prioritize implementing organizational-level strategies, recognizing burnout is often rooted in working environment and organizational culture. Management should focus on effective organizational strategies and implement them with appropriate intensity.
Wiederhold et al. [20]	Limited high-quality evidence (few RCTs). Methodological weaknesses (many lacked adequate controls).	Future interventions: holistic perspective, integrating broader techniques. More methodologically rigorous research (more RCTs, well-balanced controls). Consider interventions early in training, linked with work-directed organizational changes. Research influence of personality traits for individualized interventions.	Healthcare organizations: develop/implement individual & systems-level approaches. Balance service responsibilities & personal training/well-being. Preventive training (resilience, coping) early in careers.
Clough et al. [26]	No formal risk of bias Assessment. No meta-analysis (low quality, heterogeneity, insufficient data). Measurement heterogeneity (acceptability/satisfaction).	Need more high-quality RCTs. Use appropriate comparison groups, relevant stats, comprehensive assessment (group/individual), long-term follow-up, measure acceptability/feasibility. Consistency in reporting outcomes (raw data/effect sizes). Investigate active components for burnout. Standardized measures for satisfaction, rigorous reporting of adherence.	Widespread use of psychosocial interventions (esp. CBT) not confidently recommended due to low-quality evidence. Interventions must be non-intrusive, integrable into demanding schedules. Cost-effectiveness needs research.
West et al. [6]	Sporadic reporting of participant demographics (limits subgroup analysis). Many cohort studies high risk of bias (limited confounder control). Methodological differences/limitations in RCTs.	Establish which interventions most effective for specific populations. Investigate combining individual/ organizational solutions. Clarify optimal approaches for development/implementation (feasibility, costs). Investigate long-term sustainability, need for periodic re-exposure.	Both individual-focused and structural/organizational strategies should be considered. Engaging physicians in design/ implementation may enhance control/engagement and effectiveness.
Panagioti et al. [19]	Heterogeneity (low to moderate, but caution with subgroups). Focus on MBI EE as core outcome.	More effective intervention models needed. Future research: focus on prevention in less experienced physicians. Large-scale cluster-RCTs of institutional/ national programs emphasizing organizational culture (safe spaces for stress).	Adopt organization-directed approaches to boost small benefits. View burnout as problem of whole health care organization.

Continued

Author (Year)	Limitations of the SR/MA (as stated by its authors)	SR/MA Authors' recommendations for future research	SR/MA authors' recommendations for practice/Policy
Williams et al. [25]	No hand searching. Definition of burnout overlap with stress/mood disorders. Excluding depression/anxiety studies might limit scope.	More research to identify/intervene earlier (undergraduate). Larger longitudinal studies (burnout reduction effect on depression, anxiety, suicide). Outcome research on attrition. Research premedical student burnout/suicide prevention.	Current evidence can be used in developing future burnout mitigation programs for medical students/residents.
Bazargan-Hejazi et al. [24]	Search scope (no Web of Science/Scopus). Selection bias (subgroup of positive psychology interventions). Language bias (English only). No neta-analysis (heterogeneity).	Evaluate PERMA as guiding framework for system-directed interventions. Explore how PERMA can disentangle individual, interpersonal, institutional levels. More burnout data from low- to middle-income countries.	(Implicitly) Consider PERMA model components when designing well-being and burnout reduction interventions.
McCray et al. [23]	Potential selection bias in search terms. Exclusion of other health professions. Medical student interventions not directly applicable to residents. Exclusion of WHL studies. Potential reviewer bias.	Prospective, controlled studies needed for resident burnout interventions. Use standardized methods, larger samples, validated outcomes. Investigate meditation-type practices with more rigorous designs.	Highlights need for more effective, well-researched interventions for high resident burnout.

NR = Not Reported. MBI = Maslach Burnout Inventory. EE = Emotional Exhaustion. PA = Personal Accomplishment. RCT = Randomized Controlled Trial. NRT = Non-Randomized Trial. QI = Quality Improvement. EHR = Electronic Health Record. MBSR = Mindfulness-Based Stress Reduction. MBCT = Mindfulness-Based Cognitive Therapy. PERMA = Positive emotion, Engagement, Relationships, Meaning, Achievements. WHL = Work Hour Limitation.