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A proposed socio-technical demand–resource equilibrium model for burnout mitigation

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ABSTRACT

Research on burnout mitigation is expanding rapidly. However, the evidence remains fragmented and is often confined to healthcare or education-specific contexts. To improve transferability across broader work systems, this study conceptualizes burnout mitigation as a socio-technical and ergonomic problem. A structured narrative review combined with exploratory bibliometric analysis was conducted using Scopus-indexed literature. Literature identification and selection adopted PRISMA-informed screening procedures. After screening and eligibility assessment, 13 studies were included in the final review corpus. Bibliometric mapping was performed using VOSviewer (v1.6.20) to explore thematic relationships and keyword co-occurrence patterns. The exploratory bibliometric mapping identified thematic concentrations around individual recovery and resilience, peer and community support, technology-mediated work redesign, and organizational or macroergonomic interventions. The findings indicate a gradual shift from prevalence-oriented burnout research toward mitigation-focused and prevention-oriented approaches. The study proposes the Socio-Technical Demand–Resource Equilibrium Model (SoTDREM) as a conceptual framework for burnout mitigation, advancing macroergonomic theory by positioning burnout mitigation as systemic design optimization rather than individual resilience enhancement. The framework offers a preliminary conceptual structure that can inform future ergonomic assessment and empirical validation of burnout mitigation strategies across sectors.

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1. INTRODUCTION

Burnout has emerged as a critical challenge in contemporary work systems because its consequences extend beyond individual wellbeing to affect productivity, cognitive functioning, workforce retention, and organizational sustainability. The World Health Organization conceptualizes burnout as an occupational

phenomenon resulting from chronic workplace stress that has not been successfully managed [1], [2]. Although burnout has traditionally been defined through emotional exhaustion, cynicism, and reduced professional efficacy [3], its persistence across diverse occupational sectors suggests that burnout should not be interpreted solely as an individual psychological syndrome, but also as an indicator of work-system imbalance.

The persistence and cross-sector expansion of burnout suggest the need for a broader explanatory framework. Although burnout is often studied within specific occupations, its underlying mechanisms are fundamentally socio technical. These mechanisms are characterized by sustained high demands, limited recovery opportunities, inadequate resources, and misaligned work design. From a socio-technical and macroergonomic perspective, burnout can be understood as the outcome of misalignment among people, tasks, technology, organization, and environment [4], [5]. When work demands accumulate across these interdependent subsystems while recovery opportunities and organizational resources remain insufficient, chronic demand-resource disequilibrium may occur. In this sense, burnout represents not merely a personal failure to cope, but a signal of systemic misalignment within the work system [6]–[9].

Recent empirical literature increasingly supports this structural framing. Ergo-cognitive workload models [10] and psychosocial ergonomic frameworks [11] demonstrate that burnout correlates more strongly with workload intensity and system design misalignment than with dispositional traits alone. Simultaneously, bibliometric evidence reveals a paradigm shift. Early post-pandemic literature emphasizes prevalence and emotional stress. Recent publications increasingly examine mitigation strategies, workload calibration, digital ergonomics, and system-level interventions. This shift warrants theoretical integration.

Across healthcare, pathology, pharmacy, surgery, and crisis-related work contexts, burnout is repeatedly associated with workload intensity, staffing shortages, administrative burden, scheduling inflexibility, digital workload, and insufficient organizational support [12]–[15]. Although these studies were conducted in different occupational settings, they reveal a common pattern: burnout tends to emerge when work-system demands exceed the resources available to sustain performance and recovery.

Despite the growing body of burnout research, three gaps remain. First, existing reviews are still dominated by healthcare and education contexts, limiting transferability to broader socio-technical work systems. Second, much of the literature emphasizes prevalence, determinants, and consequences, whereas mitigation strategies are less frequently synthesized. Third, existing frameworks remain largely grounded in psychological or occupational stress perspectives, with limited integration of socio-technical systems and macroergonomic theory. Finally, few studies combine evidence synthesis with bibliometric mapping to explore the intellectual development and thematic evolution of burnout mitigation research. To address these limitations, bibliometric mapping is incorporated as a complementary analytical approach. While narrative synthesis facilitates conceptual integration of empirical findings, bibliometric analysis enables visualization of thematic relationships, keyword structures, and emerging research directions. Together, these approaches provide a more comprehensive understanding of burnout mitigation literature.

Most mitigation research evaluates isolated interventions such as mindfulness training [16], structured mental fitness programs [15], or peer-based supports [17] without consistently embedding them in a holistic work system redesign logic. These findings challenge purely individualistic interpretations and point toward systemic work design factors. Macroergonomics and socio-technical system theory offer a way to integrate these findings by treating burnout mitigation as the outcome of aligning the core work system across people, tasks, technology, organization, and environment sawaragi [18]–[23].

Unlike previous burnout reviews that predominantly examine psychological determinants or occupation-specific interventions, this study integrates structured narrative synthesis and exploratory bibliometric mapping within a socio-technical and macroergonomic perspective. This study proposes conceptualizing burnout mitigation as a demand-resource equilibrium problem embedded within the broader work system in the Socio-Technical Demand–Resource Equilibrium Model (SoTDREM) as a preliminary framework for future empirical validation.

The proposed macroergonomic perspective is not intended to replace the Job Demands–Resources (JD-R) model, which remains one of the most influential frameworks for explaining burnout. Rather, it complements and extends JD-R by examining how job demands and resources emerge from broader socio-technical system configurations. While JD-R primarily focuses on relationships between job characteristics and employee wellbeing [24], macroergonomics emphasizes interactions among people, tasks, technologies,

organizational structures, and environmental conditions that collectively shape demand-resource dynamics [4], [6], [7]. This broader perspective enables burnout mitigation to be approached as a system redesign challenge rather than solely an individual adaptation problem. Based on the identified research gaps, this study addresses the following research questions:

a. What burnout mitigation strategies have been reported in the contemporary literature?
b. How has burnout mitigation research evolved based on bibliometric patterns and thematic development?
c. What socio-technical and macroergonomic factors are associated with burnout mitigation across different work settings?
d. How can these findings be synthesized into a socio-technical and macroergonomic framework for burnout mitigation?

Accordingly, this study aims to synthesize contemporary burnout mitigation literature, map the thematic development of mitigation-oriented research, identify socio-technical and macroergonomic factors associated with burnout mitigation, and develop an integrative conceptual framework for system-level burnout mitigation.

2. MATERIALS AND METHODS

2.1. Research Design

This study employed a structured narrative review combined with exploratory bibliometric analysis to synthesize and map contemporary burnout mitigation literature. PRISMA-informed procedures were used to guide literature identification, screening, and reporting in a transparent manner. However, the study was not conducted as a formal systematic review or meta-analysis. Instead, PRISMA principles were used as methodological guidance for structured literature screening and reporting. Bibliometric mapping was conducted using VOSviewer version 1.6.20 to explore thematic relationships and intellectual structures within the selected literature corpus.

2.2. Search Strategy and Database Selection

This approach leverages the PRISMA framework Figure 1 to guarantee a thorough and replicable literature review [25], [26], as well as provide a clear and transparent picture of the topics being researched through a bibliometric approach [27], [28]. The search strategy intentionally focused on publications explicitly addressing burnout mitigation as a central topic. Although broader search terms such as burnout prevention, burnout reduction, burnout intervention, and burnout management may identify additional studies, the present review prioritized conceptual specificity to ensure thematic consistency. This focused approach allowed a more precise examination of mitigation-oriented literature within a socio-technical and macroergonomic perspective.

The search was conducted on 2 August 2025 using the keyword phrase “burnout mitigation” within the Scopus database. The search was intentionally restricted to this specific term because the objective was to examine literature explicitly focused on mitigation-oriented approaches rather than the broader burnout field. This focused strategy facilitated thematic consistency and improved the interpretability of the subsequent bibliometric mapping.

Scopus was selected as the primary database because it provides extensive multidisciplinary coverage, rigorous indexing standards, citation tracking capabilities, and compatibility with bibliometric analysis software such as VOSviewer. The use of a single database ensured consistency in retrieval procedures and bibliometric mapping. Nevertheless, studies indexed exclusively in other databases may not have been captured and would be considered a limitation of the present review.

2.3. Inclusion and Exclusion Criteria

Two Indonesian ergonomics-related studies were incorporated as supplementary theoretical references to strengthen the macroergonomic interpretation of burnout mitigation. These studies were not included in the primary review corpus used for bibliometric mapping or thematic synthesis. Their role was conceptual rather than evidential and they served only to support the discussion of ergonomic and socio-technical perspectives [10], [11]. Studies were included when they met the following criteria:

1. Published in peer-reviewed journals.

2. Written in English.
3. Focused explicitly on burnout mitigation.
4. Involved human populations.
5. Provided empirical, applied, or conceptual evidence relevant to burnout mitigation.

Studies were excluded when they:

1. Were conference proceedings, editorials, book chapters, or opinion papers.
2. Written in non-English language.
3. Focused solely on burnout prevalence without discussing mitigation approaches.
4. Involved non-human populations.
5. Mentioned burnout mitigation only superficially.

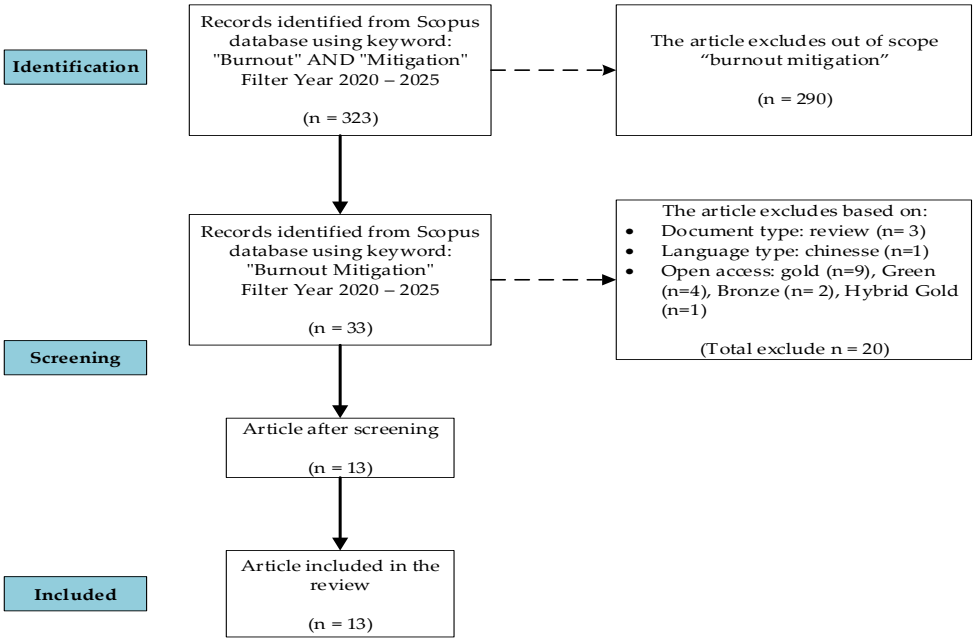


Figure 1. Adapted PRISMA-informed screening procedures

2.4. Literature Screening Process and Data Extraction

The literature selection process followed three stages consisting of identification, screening, and inclusion. Records retrieved from the database were first screened based on title and abstract relevance. Potentially relevant studies were then subjected to full-text assessment. Studies that did not explicitly discuss burnout mitigation strategies, interventions, organizational practices, or prevention mechanisms were excluded. The complete workflow is illustrated in Figure 1.

Data extracted from each study included publication year, country, study context, target population, burnout mitigation strategy, intervention level (individual, peer/team, technological, organizational), and reported outcomes. These data were subsequently synthesized using a socio-technical systems perspective to identify common themes and intervention mechanisms.

Following extraction, findings were compared across studies and grouped according to recurring intervention mechanisms and socio-technical characteristics. Similar concepts were iteratively clustered into higher-order themes representing individual, peer/community, technological, and organizational levels of burnout mitigation. The thematic synthesis was subsequently interpreted through a socio-technical and macroergonomic lens to support framework proposition (Table 1 and Figure 5).

2.5. Bibliometric Analysis

Bibliometric mapping was conducted using VOSviewer version 1.6.20. Dominant indexed keywords were extracted from the Scopus database (minimum occurrence ≥ 2; full counting method). Twenty keywords met the inclusion threshold and were included in the co-occurrence network. Keyword co-occurrence analysis was performed to explore thematic relationships among the selected studies. Given the relatively small corpus

size (n = 13), the bibliometric findings would be interpreted as exploratory rather than definitive representations of the broader burnout literature. The analysis was intended to complement the narrative synthesis by highlighting emerging thematic structures and research directions. The combination of bibliometric and structured narrative review helped the researchers synthesize empirical findings as well as map the research landscape, including identifying key contributors and emerging trends. The integration of these two approaches provides a thorough understanding [27], [28].

2.6. Quality Appraisal and Risk of Bias

Formal quality appraisal and risk-of-bias assessment were not conducted because the present study was designed as a structured narrative review rather than a systematic review or meta-analysis. The primary objective was conceptual synthesis and framework proposition rather than quantitative evidence evaluation. This methodological limitation would be considered when interpreting the findings.

3. RESULTS

This study adopted a structured conceptual synthesis methodology. Rather than conducting a statistical meta-analysis, we integrated theoretical and empirical insights from 13 peer-reviewed studies. These studies represent multiple domains, including burnout measurement, workload design, cognitive ergonomics, digital burden, organizational support, psychosocial risk, gender-based exposure, and resilience interventions.

3.1. Relevance of Burnout Mitigation Research

In contrast shown at Figure 1, publications appearing during 2024–2025 increasingly emphasized mitigation-oriented approaches, including workload redesign, organizational support mechanisms, resilience programs, digital ergonomics, and AI-assisted workload management. This shift may reflect growing recognition that burnout should be addressed through preventive and systemic interventions rather than solely through individual coping strategies. This evolution suggests that burnout is no longer viewed solely as an outcome requiring measurement, but as an organizational challenge requiring systematic mitigation and work-system redesign. Nevertheless, because the corpus is relatively small, these observations would be interpreted as indicative trends rather than definitive evidence of field-wide evolution.

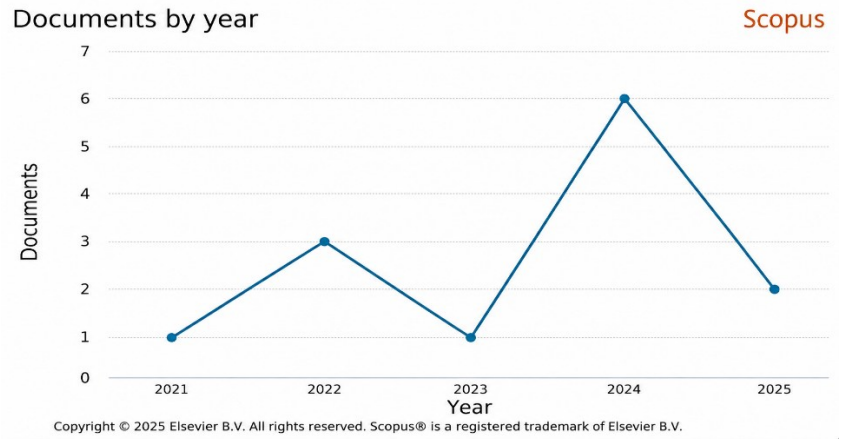
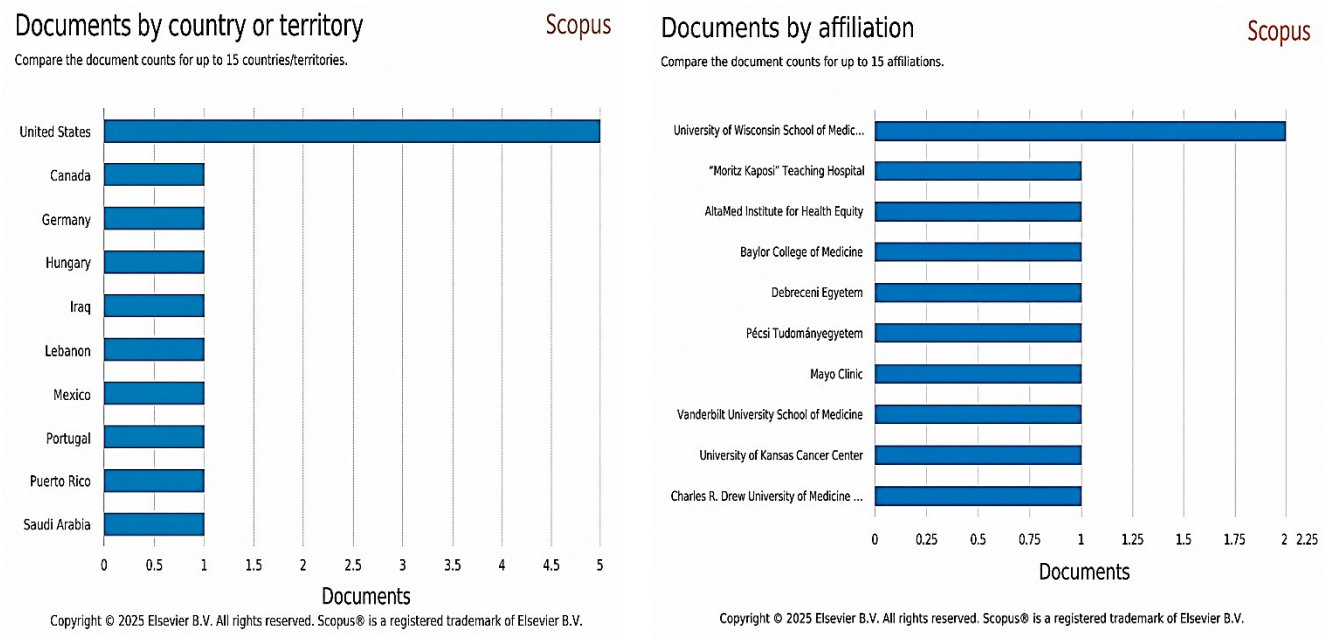


Figure 1. Document by year

3.2. Current Research Landscape

The geographical and sectoral concentration, shown at Figure 2, observed in the reviewed literature also highlights an important limitation of the current evidence base. Because most studies originate from healthcare settings in developed countries, existing mitigation frameworks may insufficiently capture the complexity of other socio-technical environments such as manufacturing, transportation, logistics, public services, and digital industries. Consequently, the transferability of burnout mitigation strategies across sectors remains an important area for future investigation.



(a) Distribution of studies by country (b) Distribution by affiliation

Figure 2. Distribution of studies by country and affiliation

3.3. Thematic Structure and Implications from Bibliometric Structural Mapping

Table 1 shows that the dominance of demographic descriptors such as human, female, and male reflects the continuing emphasis on population-level characterization within burnout research. However, the emergence of burnout mitigation, workload, and mindfulness among more recent keywords suggests increasing attention to intervention mechanisms rather than solely describing affected populations.

Table 1. Key quantitative indicators

Keyword	Occurrences	Total Link Strength	Avg Pub Year	Norm. Citations
Human	10	78	2023.10	0.77
Female	9	74	2023.11	0.74
Male	9	74	2023.11	0.74
Burnout	9	62	2023.11	0.82
Workload	3	11	2023.67	**2.15**
burnout mitigation	2	11	2024	0.09
Mindfulness	2	11	2024	0.09

Bibliometric mapping showed a dense core around 'burnout' and 'burnout, professional', connected to 'human', 'adult', and gender terms ('female', 'male'). A mitigation-oriented cluster connected 'burnout mitigation' with 'mindfulness', 'job satisfaction', and 'workload', suggesting a dual emphasis on individual skills and work design levers. The network highlighted central terms (e.g., burnout, burnout mitigation, mindfulness, workload, job satisfaction) and their interconnections, supporting triangulation of themes with the SLR synthesis.

Collectively, the three clusters illustrate a progression from exposure identification toward mitigation design. While the red cluster characterizes workforce exposure patterns, the green cluster highlights protective mechanisms, and the blue cluster captures contextual stressors associated with crisis conditions. This pattern reinforces the socio-technical interpretation that burnout mitigation requires simultaneous consideration of demand sources, contextual pressures, and resource-enhancing interventions.

Table 2 and Figure 4 suggests three dominant thematic clusters: (1) demographic and workload-related descriptors (e.g., human, female/male, adult, workload, prevention and control); (2) wellbeing and mitigation

mechanisms (e.g., job satisfaction, health care personnel, mindfulness); and (3) pandemic-related stress pathways and profession-specific concerns (e.g., depersonalization, emotional stress, pharmacist, prevalence).

Table 2. Keyword clusters (VOSviewer co-occurrence output; condensed)

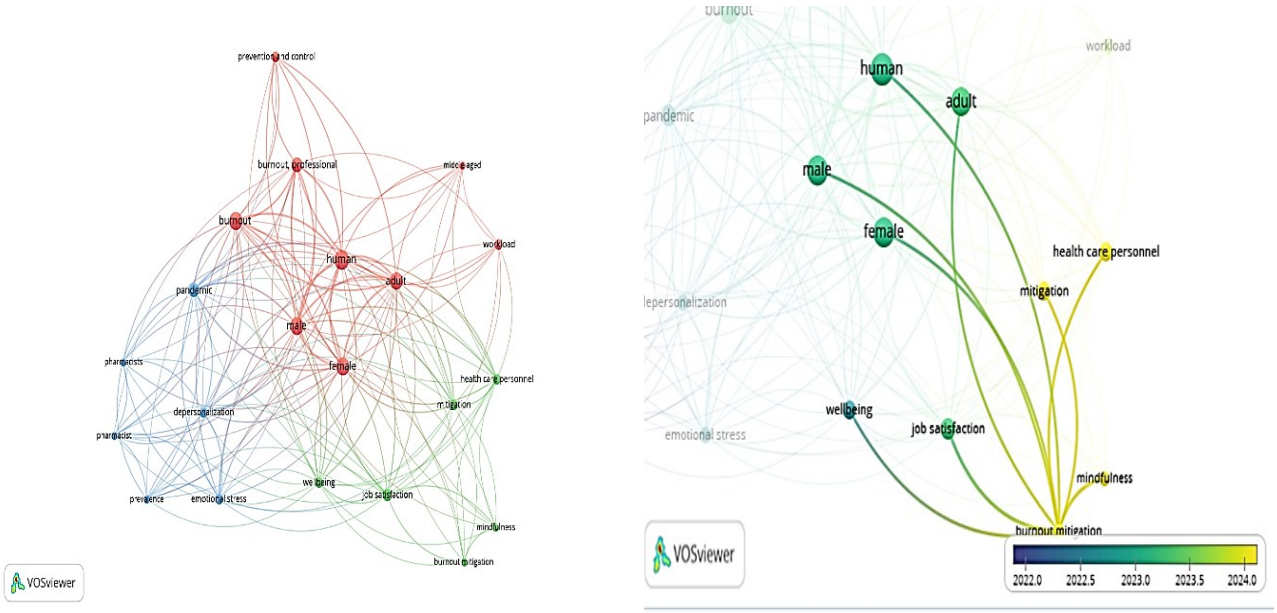
Cluster	Representative keywords	Interpretation	Macroergonomic implication	Total link strength	Avg Year
(Red) **Demographic and Population Characteristics**	human; burnout; female; male; adult; workload; prevention and control	Population descriptors associated with burnout-related studies	Identification of demographic exposure patterns and workforce characteristics relevant to burnout mitigation.	62–78	2023
(Green) **Mitigation & Wellbeing**	job satisfaction; health care personnel; mitigation; wellbeing; mindfulness	Protective resources and intervention mechanisms.	Design integrated resource pathways (support, autonomy, flexibility, training).	11–29	2024
(Blue) **Crisis & Prevalence**	pandemic; depersonalization ; emotional stress; pharmacist(s); prevalence	Crisis context and profession-specific vulnerability.	Build adaptive organisational capacity and role specific mitigation toolkits.	22–45	2022

Although the three clusters appear distinct, the network structure suggests strong thematic interdependence. Demographic and workload-related characteristics form the exposure context in which burnout develops, while wellbeing and mitigation mechanisms represent potential resource pathways capable of reducing burnout intensity. Pandemic-related and profession-specific themes provide contextual conditions that may amplify demand-resource imbalance. Together, these clusters indicate that burnout mitigation emerges from interactions among individual, organizational, and environmental factors rather than from isolated interventions.

The observed evolution also reflects a broader transition from individual-centered interpretations of burnout toward system-oriented perspectives. Emerging themes increasingly recognize the importance of work design, organizational resources, digital ergonomics, and socio-technical interventions in addressing burnout. Although the relatively small corpus limits the strength of temporal generalizations, the overlay visualization indicates a growing scholarly interest in proactive and sustainable burnout mitigation approaches rather than solely documenting burnout prevalence and severity. The resulting network structures would be interpreted as exploratory thematic patterns rather than stable representations of the broader burnout literature, because the bibliometric corpus consisted of only 13 studies. Accordingly, the bibliometric findings are used to complement the narrative synthesis rather than to establish definitive intellectual structures.

The overlay visualization (Figure 4) reveals more than a temporal change in keywords. It reflects a conceptual transition in how burnout is understood within the literature. Earlier studies concentrated on documenting burnout prevalence, emotional exhaustion, and profession-specific vulnerability, particularly during crisis conditions such as the COVID-19 pandemic. In contrast, recent studies increasingly investigate how burnout can be prevented, mitigated, or managed through organizational support, workload redesign, wellbeing programs, and technology-enabled interventions. This transition suggests a maturation of the field from problem identification toward solution-oriented research.

From a macroergonomic perspective, this trend is particularly significant because it demonstrates increasing recognition that burnout cannot be effectively addressed through individual coping strategies alone. The emergence of keywords related to workload, organizational support, digital systems, and wellbeing suggests that researchers are increasingly examining burnout as a socio-technical phenomenon shaped by interactions among people, tasks, technologies, organizational arrangements, and environmental conditions.



(a) Network visualization (b) Overlay visualization

Figure 3. Network visualization based on VOSviewer output by co-occurrence keyword: (a) Network visualization clusters and (b) Overlay visualization with opportunity research theme.

The intellectual trajectory suggests a shift from crisis response documentation toward proactive system redesign. Workload-driven system explanations increasingly dominate scholarly discourse. These clusters highlight the need for macroergonomic integration rather than treating burnout as an individual deficit; mitigation should be designed as a socio-technical intervention that reconfigures system stressors while strengthening individual and collective resources. Individual resilience alone is an insufficient buffer against systemic failure. Support systems are prioritized based on their proven ability to mitigate burnout and build "Burnout Resilience" [14].

Synthesis of the reviewed studies identified four recurring categories of burnout mitigation strategies: (1) individual recovery and capability enhancement, including mindfulness and mental fitness programs; (2) peer and community-based resources that strengthen social support and collective efficacy; (3) technology-mediated interventions that either reduce or exacerbate workload depending on usability and governance; and (4) organizational and macroergonomic interventions targeting staffing, workload allocation, leadership support, and work-system redesign. These categories demonstrate that burnout mitigation operates across multiple socio-technical levels rather than within a single intervention domain.

4. DISCUSSION

4.1 Principal Findings

The findings of this review indicate that burnout is increasingly recognized as a systemic phenomenon rather than solely an individual psychological condition. Across the reviewed studies, burnout consistently emerged from chronic imbalances between work demands and available resources. These imbalances were associated with workload intensity, staffing adequacy, leadership climate, digital workload, organizational support, and work-system design. Collectively, the evidence suggests that sustainable burnout mitigation requires interventions that address structural conditions rather than relying exclusively on individual coping mechanisms.

The post-pandemic escalation in burnout prevalence (up to 87.6% among Health System Pharmacists) indicates a structural overload condition rather than insufficient resilience. If individual practitioners are operating at peak exhaustion, the burden of mitigation must shift from the person to the system [12]. This study reframes burnout as a systemic disequilibrium within a socio-technical configuration rather than as an individual psychological deficit.

Across the synthesized evidence based on Table 3, burnout consistently emerges as the result of a chronic imbalance between work demands and available resources. These imbalances are embedded in five interacting subsystems: People, Tasks, Technology, Organization, and Environment. Empirical findings demonstrate that burnout prevalence is not personal weakness but strongly associated with staffing inadequacy, administrative burden, leadership climate, and digital workload [12], [13], [29]. Data confirms that while all supports are valuable, organizational and structural levers are the primary drivers for attenuating work-related exhaustion.

Across the reviewed studies, burnout mitigation is best understood as a multilevel prevention and intervention continuum. Consistent with macroergonomics, interventions should be embedded within a socio-technical diagnosis of the work system, enabling participatory redesign of tasks, tools/technology, workflows, and organizational structures. Drawing on organizational stressor models and social-ecological perspectives, an integrative pathway is proposed in which common workplace stressors serve as inputs, processed through organizational/system assessment and participatory design, to prevent downstream physical, psychological, and behavioral consequences.

Table 3. Core work system (Socio-technical configuration)

Subsystem	Demand Drivers	Resource Mechanisms
People	Recovery depletion, gendered exposure	Coping capacity, mental fitness
Tasks	Workload intensity, temporal pressure	Autonomy, role clarity
Technology	Digital workload, AI surveillance	Usability, AI support tools
Organization	Staffing shortages, leadership gaps	Supportive management
Environment	Shift irregularity, boundary blurring	Work-life integration and boundary control

Taken together, these findings suggest that burnout should be interpreted less as an individual health outcome and more as an indicator of work-system performance. The consistency of structural drivers across occupations indicates that burnout emerges when socio-technical systems fail to maintain a sustainable balance between demands and available resources. This interpretation shifts the focus of mitigation from individual adaptation toward system redesign and organizational responsibility.

4.2 Theoretical Contributions

The principal theoretical contribution of this study lies in the integration of burnout mitigation literature within a socio-technical and macroergonomic framework. Rather than conceptualizing burnout exclusively as a psychological outcome, the proposed perspective positions burnout as a manifestation of demand-resource disequilibrium occurring across multiple work-system components. This perspective extends existing burnout theories by emphasizing interactions among people, tasks, technology, organization, and environment.

This study contributes to macroergonomics scholars in three principal ways: (i) Conceptual Advancement: It operationalizes burnout as a system level equilibrium construct rather than a psychological state. (ii) Socio-Technical Integration: It explicitly links workload, digital design, leadership climate, and environmental boundary conditions within one coherent framework. (iii) Measurement Orientation: It positions burnout dimensions as diagnostic indicators of systemic misalignment.

The proposed SoTDREM framework in Figure 4 does not replace the Job Demands–Resources (JD-R) model. Instead, it extends the JD-R perspective by embedding demand-resource dynamics within a broader socio-technical work system. While JD-R primarily focuses on psychological and organizational demand-resource relationships, SoTDREM explicitly incorporates macroergonomic interactions among people, tasks, technology, organization, and environmental conditions. Consequently, the framework provides a more comprehensive explanation of how demands and resources are generated, distributed, and managed across complex work systems.

The novelty of SoTDREM lies not in introducing a new burnout construct, but in repositioning burnout within a socio-technical systems architecture. Existing burnout theories primarily explain why burnout occurs at the individual or organizational level. In contrast, SoTDREM conceptualizes burnout as an emergent property of interactions among people, tasks, technology, organization, and environmental conditions. This

broader perspective enables burnout mitigation to be examined as a system-design challenge rather than solely a psychological intervention problem.

4.3 Practical Implications

Framing burnout mitigation as a socio-technical and macroergonomic problem helps explain why isolated training programs often show limited long-term effectiveness when structural drivers remain unchanged. Mindfulness or mental fitness training may improve coping capacity, but without workload redesign and supportive leadership, the demand resource imbalance persists [15], [16]. The synthesis suggests practical ergonomics implications. At the task level, organizations should quantify and redesign cognitive workload, administrative burden, and temporal pressure, particularly for digitally mediated tasks where usability and workflow fit are critical [30]. At the organizational level, mitigation should prioritize staffing adequacy, equitable scheduling, and supportive supervisory practices, which are repeatedly associated with burnout prevalence and turnover intent [12], [13], [29].

At the social system level, peer learning and storytelling interventions can serve as low work-life cost resources that strengthen meaning, connectedness, and shared problem solving [17], [31]. Contextualized support, such as mission-driven ethos and shared language, may be especially important under crisis conditions [32], [33]. AI-enabled technologies should be evaluated as socio-technical interventions rather than standalone technological solutions. Their effectiveness depends not only on technological capability but also on organizational governance, workflow integration, user competence, leadership support, and workload characteristics. Consequently, AI should be viewed as one component within a broader socio-technical redesign strategy rather than as an independent burnout mitigation mechanism. Their value depends on governance integration into work practices and their ability to reduce, without adding cognitive and coordination load [34].

Following widely used prevention logic, mitigation strategies may be grouped as: (i) primary prevention (modifying or eliminating workplace stressors through redesign of jobs, schedules, and environments); (ii) secondary prevention (modifying individual and collective responses via skill training, relaxation techniques, and workplace social support); and (iii) tertiary prevention (treating negative outcomes through employee assistance programs, counselling, and medical/psychological care). A macroergonomic contribution is to ensure that individual supports do not substitute for system redesign but rather complement structural improvements. Across the reviewed studies, mitigation strategies could be grouped into four socio-technical layers. First, individual capability and recovery interventions, including mindfulness-based approaches and emotion regulation support [16] and structured mental fitness programs [15]. Second, peer and community resources, including peer learning mechanisms in academic settings [17] and informal social support such as pet companionship, which was associated with lower emotional exhaustion in radiology work contexts [35]. Third, technology-mediated redesign emerges as both a risk and an opportunity. EHR related digital workload and usability issues can intensify burnout risk [30], while generative AI tools such as ChatGPT have been explored as potential support for information management and coping, though with clear requirements for safe governance and workflow integration [34]. Fourth, organizational and macroergonomic mitigation leverages leadership, workload equity, and resource allocation. Safety net settings highlighted mission-driven culture, supportive management, and structured coordination as practical mitigation mechanisms under crisis conditions [32]. Evidence from pharmacy and pathology contexts further underscores that work hours, administrative burden, and staffing models are consistent drivers of burnout and targets for system level redesign [12], [13], [29]. Gender-differentiated patterns indicate that workload and role boundary conditions may need tailoring to reduce inequitable exposure [33].

Individual-focused interventions (mindfulness, mental fitness) show short term improvements in emotional regulation. However, evidence in the reviewed corpus indicates that such strategies act only as temporary buffers. Reliance on individual coping constitutes a risk management failure when systemic stressors remain unchanged. The equilibrium framework, as shown in Table 4, therefore classifies micro level strategies as secondary prevention, insufficient without system redesign. Micro level interventions (mindfulness, selfcare) are effective for symptom regulation, while macro level interventions (ergocognitive redesign, workload calibration, AI support) show potential structural sustainability.

Peer-assisted mechanisms such as Informal Peer Assisted Learning (IPAL) significantly mitigate cynicism and inadequacy by recalibrating expectations and restoring collective efficacy. These findings highlight that

burnout contains a social cognitive component that requires relational buffering. Similarly, leadership support and mission-driven organizational climate function as stabilizing resources under high demand conditions. The framework integrates these as organizational resource amplifiers, capable of moderating demand intensity without altering task structure.

Table 4. Burnout mitigation interventions across system levels

Ref.	Level	Intervention Type	Core Finding	System Implication
[16]	Micro	Mindfulness	Improves emotional regulation	Short term emotional buffering
[14]	Micro	Resilience training	Reduces burnout severity	Adaptive coping
[15]	Micro	Mental fitness	Improves recovery capacity	Short term Individual reserve, Recovery enhancement
[35]	Micro	Companion support	Reduces stress biomarkers	Emotional buffering
[31]	Micro	Selfcare models	Improves wellbeing	Behavioral support
[17]	Meso	Peer learning	Enhances collective efficacy	Social resource reinforcement
[33]	Meso	Work-life boundary	Gender sensitive mitigation	Exposure moderation
[13]	Meso	Leadership support	Reduces cynicism	Organizational climate stabilization
[32]	Meso	Safety net systems	Enhances psychological safety	Organizational buffering
[34]	Macro	AI support tools	Reduces cognitive overload	Tech enabled load redistribution
[30]	Macro	EHR usability	Reduces digital strain	System usability alignment, Cognitive load reduction
[12]	Macro	Structural stratification	Identifies workload inequity	Structural redesign need
[29]	Macro	System evaluation	Multilevel burnout predictors	System alignment
[10]	Macro	Ergocognitive model	Links workload to burnout	Cognitive ergonomics
[11]	Macro	Psychosocial ergonomics	Work system redesign	Macroergonomic and System alignment

The strongest explanatory power in the reviewed literature resides at the structural level. Digital workload and EHR usability deficits significantly intensify cognitive strain. Conversely, AI-enabled tools may redistribute load if integrated under proper governance. Technology thus operates in a dual role subsystem, either a demand amplifier or a resource redistributor. Structural supports (e.g., childcare access) show a stronger mitigation impact than familial support alone. This reinforces the macroergonomic premise that sustainable mitigation must prioritize organizational and structural levers over private coping mechanisms.

By synthesizing ergocognitive, psychosocial, and organizational stressor models, the framework expands macroergonomic applications into digitally mediated and high reliability environments. From an operational standpoint, the findings suggest that burnout mitigation must shift from wellness programming to infrastructure redesign. It is specifically suggested to quantify and recalibrate cognitive workload at the task level, redesign staffing and scheduling systems, evaluate digital usability before technological deployment, institutionalize peer learning mechanisms as structured social resources, treat leadership climate as a controllable system variable.

A central implication of the findings is that burnout mitigation should be treated as a design problem rather than solely a wellbeing problem. Organizations frequently invest in resilience training and individual coping programs, yet the reviewed evidence suggests that sustainable mitigation is more likely to occur when

structural factors such as workload allocation, staffing adequacy, digital usability, leadership practices, and work-system configuration are addressed simultaneously.

4.4 Proposed SoTDREM Framework

The proposed framework provides a conceptual mechanism linking external pressures to burnout outcomes through socio-technical system interactions. Rather than treating workload, technology, leadership, and environmental conditions as separate explanatory variables, SoTDREM integrates these elements within a single equilibrium logic. This integration enables researchers and practitioners to identify which subsystem contributes most strongly to chronic demand-resource imbalance.

Figure 4 presents an integrative socio-technical burnout mitigation model synthesized from the included evidence. It links external context pressures to the core work system configuration (people, tasks, technology, organization, environment), which shapes demand-resource equilibrium. Chronic imbalance manifests as burnout dimensions and downstream wellbeing and performance outcomes; mitigation is conceptualized as a multilevel set of interventions that either reduce demands, increase resources, or realign the system. The proposed framework defines equilibrium as a dynamic state in which system level demands do not chronically exceed structural and organizational resources. Burnout mitigation, therefore, requires interventions that reduce demand drivers, increase systemic resources, and realign socio-technical configurations.

The model integrates external pressures, core work system configuration, and burnout outcomes into a coherent macroergonomic pathway: External Context → Socio-technical Configuration → Demand–Resource Balance → Burnout Dimensions → Performance & Wellbeing Outcomes. This synthesis extends macroergonomic theory by explicitly linking subsystem misalignment to burnout dimensions and operational reliability. Importantly, the framework should be interpreted as a conceptual diagnostic model rather than a predictive model at this stage. The proposed relationships are derived from thematic synthesis and socio-technical reasoning and therefore require empirical validation before causal claims can be established.

The framework proposes that socio-technical subsystem conditions influence demand-resource equilibrium, which subsequently affects burnout dimensions and organizational outcomes. As presented in Table 5, the interplay among the People, Tasks, Technology, Organization, and Environment dimensions collectively determines the balance between demands and available resources. When demands chronically exceed available resources, burnout symptoms are expected to increase. Conversely, improved socio-technical alignment is expected to strengthen wellbeing, performance, and organizational sustainability.

Table 5. Definition of SoTDREM components

Component	Definition	Level	Supporting References
People	Individual characteristics that influence burnout mitigation including coping capacity, recovery ability, resilience, skills, and wellbeing resources	Individual	[14]–[16]
Tasks	Job demands arising from workload, time pressure, complexity, and role requirements	Job/Task	[12], [13]
Technology	Digital systems, tools, AI applications, usability characteristics, and technological workload	Technological	[30], [34]
Organization	Leadership, staffing, policies, management support, and organizational climate	Organizational	[11], [13]
Environment	Physical, social, and external contextual conditions influencing work performance	Environmental/System	[17], [29], [33]

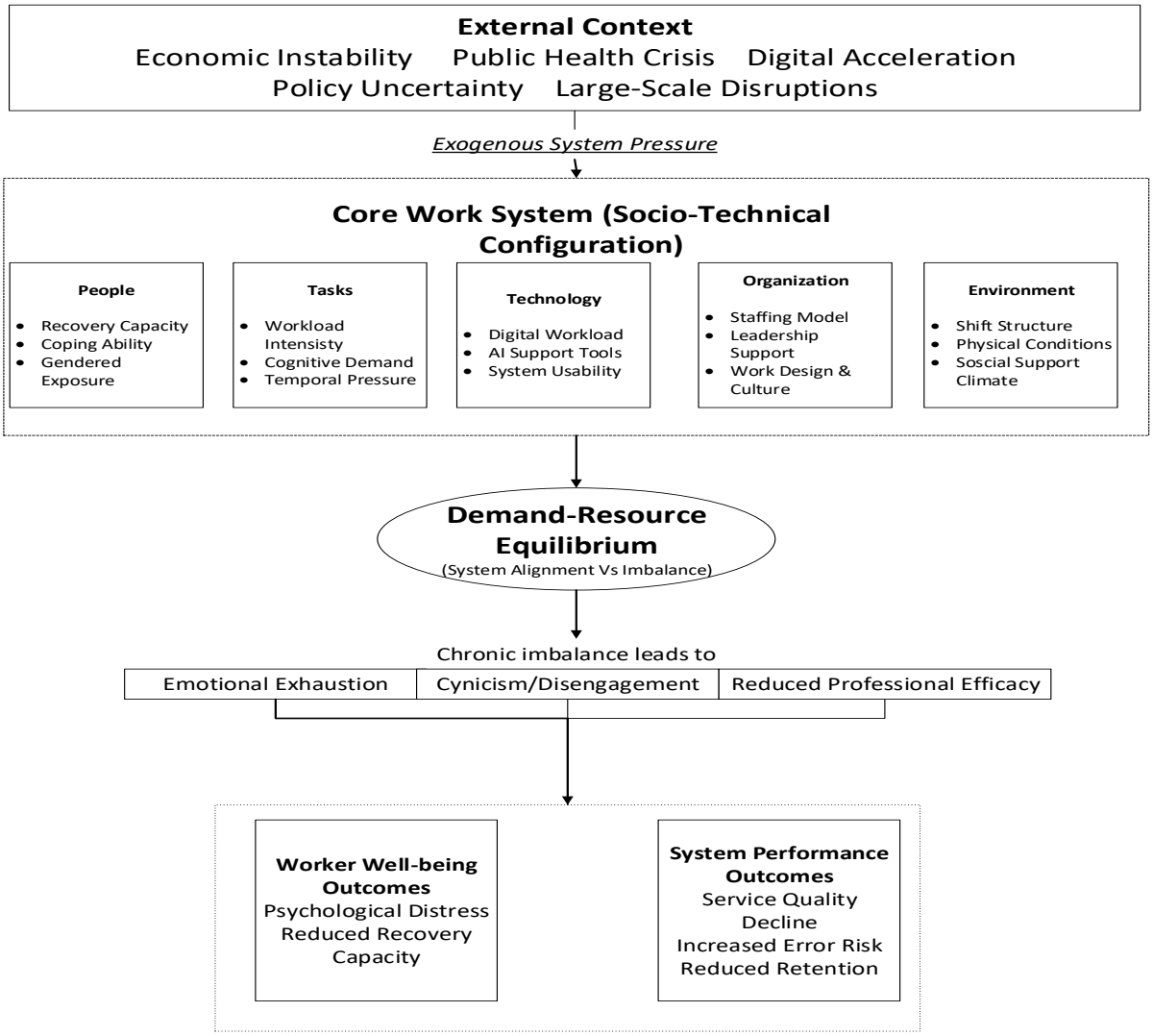


Figure 4. Proposed socio-technical demand resource equilibrium model (SoTDREM)

These indicators, shown in Table 6, are illustrative examples intended to guide future empirical validation rather than definitive measurement instruments. Rather than replacing the JD-R model, SoTDREM extends it by embedding demand-resource mechanisms within a broader socio-technical architecture. The framework therefore retains the explanatory value of demand-resource theory while incorporating macroergonomic principles that explicitly address task design, technological systems, organizational structures, and environmental conditions. The comparison shown in Table 7, While the JD-R model explains how demands and resources influence employee wellbeing, it provides limited guidance regarding how those demands and resources originate from wider socio-technical configurations. SoTDREM addresses this limitation by explicitly incorporating technological systems, environmental conditions, and work-system design factors as interacting determinants of burnout mitigation.

4.4 Limitations

This study has several limitations. First, the review corpus was relatively small and derived from a single database (Scopus), which may have limited coverage of relevant burnout mitigation studies indexed elsewhere. Some studies indexed exclusively in other databases may not have been captured and should be considered. Formal quality appraisal and risk-of-bias assessment were not conducted because the present study was designed as a structured narrative review rather than a systematic review, which limits the generalizability of thematic and bibliometric findings. Second, healthcare settings dominated the reviewed literature, potentially restricting transferability to other industries. Third, the bibliometric component was

exploratory and based on a relatively small corpus. Finally, the proposed SoTDREM framework remains conceptual and has not yet undergone empirical validation.

Table 6. Illustrative indicators for future validation

Component	Example Indicators
People	Recovery, resilience, coping capacity
Tasks	Workload, task complexity, time pressure
Technology	System usability, digital burden, AI support
Organization	Leadership support, staffing adequacy
Environment	Shift schedule, work-life boundary

Table 7. Comparison between JD-R and SoTDREM

Aspect	JD-R	SoTDREM
Primary Focus	Demand-resource in psychology	Socio-technical work system
Unit of Analysis	Individual and organization	Multilevel work system
Technology	Indirectly considered	Explicit subsystem
Environment	Limited emphasis	Explicit subsystem
Ergonomic Design	Limited	Central element
Burnout Mitigation	Resource balancing	System redesign and resource balancing

4.6 Future Research Directions

Future reviews may incorporate broader search terms such as burnout prevention, burnout reduction, burnout intervention, and burnout management as additional literature. Future research should empirically validate the SoTDREM framework across diverse industrial sectors and cultural contexts. Quantitative approaches such as structural equation modeling, multilevel analysis, longitudinal studies, and intervention-based research may provide stronger evidence regarding causal relationships among socio-technical subsystems, demand-resource equilibrium, burnout dimensions, and organizational outcomes. Future investigations should also examine the role of AI-enabled interventions, digital ergonomics, and organizational redesign strategies as integrated components of burnout mitigation systems. Future empirical studies may evaluate several research propositions derived from the framework:

a. P1: Greater socio-technical alignment is associated with lower burnout levels.
b. P2: Organizational and technological resources moderate the relationship between workload demands and burnout outcomes.
c. P3: Demand-resource equilibrium mediates the relationship between socio-technical subsystem conditions and employee wellbeing.
d. P4: Burnout functions as an observable indicator of socio-technical system misalignment.

These propositions provide a foundation for future quantitative validation using SEM, multilevel analysis, or longitudinal research designs.

5. CONCLUSION

This study demonstrates that burnout mitigation is increasingly shifting from individual-focused approaches toward socio-technical and macroergonomic interventions. The reviewed evidence suggests that sustainable burnout mitigation is most effective when multilevel strategies are integrated, combining workload redesign, organizational support, leadership improvement, technology usability, and individual recovery resources. The findings indicate that burnout should be understood as a manifestation of demand-resource imbalance occurring across interconnected work-system components rather than solely as an individual psychological condition.

The primary theoretical contribution of this study is the proposition of the Socio-Technical Demand–Resource Equilibrium Model (SoTDREM). The framework extends existing demand-resource perspectives by embedding burnout mitigation within a broader socio-technical system consisting of People, Tasks, Technology, Organization, and Environment. By integrating macroergonomic principles with demand-

resource theory, the framework conceptualizes burnout as an indicator of systemic disequilibrium and provides a foundation for future empirical investigation.

From a practical perspective, the findings suggest that organizations should prioritize system-level interventions rather than relying primarily on resilience training or individual coping programs. Effective burnout mitigation requires improvements in workload management, staffing adequacy, leadership support, digital ergonomics, technology governance, and work-system design. AI-enabled technologies should be implemented as components of broader socio-technical interventions rather than as standalone solutions.

Several limitations should be acknowledged. The review corpus was relatively small and largely dominated by healthcare-related studies, which may limit generalizability across sectors. Furthermore, the bibliometric component was exploratory and the proposed SoTDREM framework remains conceptual. Future research should empirically validate the framework using quantitative, multilevel, longitudinal, and intervention-based approaches across diverse organizational contexts. Additional studies are also needed to examine the role of digital ergonomics, AI-enabled support systems, and socio-technical redesign strategies in burnout mitigation.

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DECLARATION OF AI-TOOL USAGE

The authors used ChatGPT as an assistant for discussing and sharpening research ideas. Grammarly was used to improve grammar, spelling, and language clarity. All AI-assisted outputs were critically reviewed, revised, and verified by the authors, who take full responsibility for the accuracy, originality, and final content of the manuscript.