INPLASY

Exploring "Digital Fatigue" and Its Associations for Mental Health in Medical Students: A Scoping Review

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ADMINISTRATIVE INFORMATION

INTRODUCTION

Review question / Objective • Main Research Question How is digital fatigue conceptualized among medical students, and what is its association with mental health outcomes such as stress, anxiety, exhaustion, and academic burnout?
• Specific Questions
1) How is "digital fatigue" defined and conceptualized in the existing literature on medical students?
2) What mental health indicators are examined in relation to digital fatigue, and how are these outcomes measured?
3) What are the reported consequences of digital fatigue for medical students, particularly regarding their development, academic performance, and well-being?
4) What research methods, assessment tools, or instruments are used to evaluate digital fatigue and associated mental health outcomes?

5) What are the gaps, limitations, and inconsistencies in current research regarding the conceptualization, measurement, and population coverage of digital fatigue in medical students?

Background Face-to-face learning was long established as the norm in higher education until the unexpected outbreak of COVID-19 in 2020. The pandemic forced an abrupt transition to digital platforms to ensure continuity in education. While this digital shift increased flexibility and broadened access to learning resources, it also brought notable drawbacks. Students were required to engage with online platforms for prolonged periods, often spanning the entire day, leading to feelings of exhaustion, diminished concentration, and reduced motivation (Bailenson, 2021).

This phenomenon, referred to as "digital fatigue" or "digital burnout," is characterized by persistent tiredness, lack of energy, and cognitive and emotional exhaustion (Menting et al., 2018). Conceptually, digital fatigue encompasses multiple

sub-constructs, including visual fatigue (eye strain and screen-related discomfort), social fatigue (weariness from constant digital communication), motivational fatigue (reduced drive to engage with learning tasks), and emotional fatigue (stress and irritability linked to technology use) (Fauville et al., 2021). Related constructs have also emerged during the pandemic, such as social media fatigue (SMF) and Zoom fatigue. SMF arises from information overload due to excessive social media use and overlaps substantially with digital fatigue. Zoom fatigue refers to the physical and psychological strain associated with prolonged videoconferencing, manifesting in both immediate discomfort and longer-term well-being concerns (Webb, 2021).

University students were among the most affected groups during the pandemic-driven transition. The sudden reliance on technology increased their exposure to screens, reduced opportunities for offline engagement, and amplified the intensity of academic demands (Pandya & Lodha, 2021). The reliance on videoconferencing tools, coupled with restrictions on outdoor activities, confined students to prolonged indoor, screen-based engagement, which magnified the risks of Zoom fatigue and social media fatigue. Empirical evidence from diverse student populations—including engineering, nursing, and teacher education—has demonstrated associations between extended screen exposure and outcomes such as reduced cognitive functioning, decreased motivation, and higher stress levels (Oducado et al., 2021; Moralista et al., 2022; Baltà-Salvador et al., 2021).

Within this broader context, medical students represent a particularly vulnerable group. Medical training is inherently demanding, requiring long study hours, mastery of extensive theoretical knowledge, and early clinical exposure. These stressors make medical students more susceptible to academic burnout compared to other student groups. The pandemic further intensified these pressures, with medical students forced into remote learning environments characterized by digital overload. Recent research indicates that although medical students are highly prone to burnout, adaptive coping mechanisms and resilience-building strategies can mitigate some of the negative consequences of digital fatigue (Franco et al., 2022).

The implications of digital fatigue extend beyond short-term discomfort. At the individual level, students commonly report attention lapses, irritability, eye strain, sleep disruption, and reduced academic motivation. When sustained, these symptoms may progress to chronic burnout, heightened anxiety, depressive symptoms, and overall deterioration in psychological well-being. At the institutional level, digital fatigue undermines student engagement, learning outcomes, and academic performance, while also threatening retention rates and the long-term preparedness of healthcare professionals.

Recognizing the widespread and multidimensional nature of digital fatigue is essential for medical education. Institutions must consider strategies that balance technology use with pedagogical innovation, promote healthy screen habits, and provide targeted support systems to safeguard student well-being. Addressing digital fatigue not only supports academic success but also ensures the sustainable development of resilient future healthcare providers.

Rationale The digital transformation of medical education, accelerated by the COVID-19 pandemic, has created new opportunities for flexible learning but has also introduced unintended challenges. While digital platforms offer accessibility and continuity in training, the extensive reliance on technology has contributed to rising concerns about digital fatigue. This construct, often described as digital burnout or exhaustion, encompasses multidimensional symptoms such as visual strain, social disconnection, motivational depletion, and emotional exhaustion. Although the term has gained traction in recent years, its conceptual boundaries remain inconsistent and fragmented across the literature.

Existing studies tend to describe digital fatigue through related constructs such as social media fatigue or Zoom fatigue, each addressing a narrow aspect of the digital learning experience. While these terms capture important dimensions, they fall short of representing the broader phenomenon of digital fatigue in medical students, whose academic experiences are shaped by long study hours, heavy curricular demands, and frequent engagement with digital platforms for both learning and clinical preparation. The lack of a systematic synthesis of how digital fatigue is defined and measured creates ambiguity and undermines the ability of educators and researchers to design targeted interventions.

In addition to definitional gaps, there is limited clarity on the relationship between digital fatigue and mental health outcomes in medical students. The literature documents rising levels of stress,

anxiety, and burnout within medical education, often exacerbated by remote and digital learning environments. However, existing research tends to examine these issues in isolation, without systematically exploring how digital fatigue contributes to or interacts with psychological well-being. Understanding this association is critical, as mental health challenges in medical students are linked not only to diminished academic performance but also to professional preparedness and patient care in the long term.

Another major limitation of current evidence lies in methodological inconsistencies. Studies employ diverse tools, ranging from self-reported surveys to adapted scales, with varying operational definitions of fatigue-related constructs. Moreover, many investigations are conducted in heterogeneous student populations across non-medical disciplines, limiting the transferability of findings to medical education. There is also a paucity of longitudinal or interventional studies that could illuminate causal relationships or effective strategies to mitigate digital fatigue. These inconsistencies highlight the urgent need to map existing evidence systematically to identify patterns, overlaps, and gaps in the research.

A scoping review is therefore warranted to clarify conceptualizations of digital fatigue, synthesize evidence on its associations with mental health, and identify areas requiring further exploration. Unlike systematic reviews that focus on narrowly defined outcomes, a scoping review is particularly suited for emerging topics characterized by diverse and fragmented evidence. By mapping the breadth of literature, this review will provide an integrated understanding of how digital fatigue is defined, studied, and linked to mental health outcomes in medical students.

Ultimately, this review will serve multiple stakeholders. For researchers, it will establish a conceptual foundation for future studies and the development of standardized measurement approaches. For educators and institutions, it will highlight the consequences of digital fatigue on learning, well-being, and professional development, informing the design of interventions and policies to balance technology use in medical training. By systematically addressing these gaps, this scoping review seeks to contribute to both the academic discourse on digital health challenges and the practical improvement of medical education in a rapidly evolving digital era.

METHODS

Strategy of data synthesis

The review adhered to six stages: (1) identifying the research question; (2) identifying relevant studies; (3) selecting studies based on predefined eligibility criteria; (4) charting the data; (5) collating, summarizing, and reporting results; and (6) an optional consultation with stakeholders to explore practical relevance.

The search strategy combined controlled vocabulary from MeSH, Emtree, CINAHL Headings, and Keywords/Descriptors for WoS and synonym for (1) Population ("Medical Student", "Undergraduate Medical Education", "Medical School", "Medical College", "Clerkship", "Apprentice*"); (2) Concept about digital fatigue and its associated constructs ("Digital Fatigue", "Technostress", "Zoom Fatigue", "Videoconference Fatigue", "Online Exhaustion", "Virtual Learning Fatigue", "Digital Learning", "Online Education", "Remote Learning", etc);(3) Context in terms of mental health outcomes ("Mental Health", "Psychological Wellbeing", "Psychological Adaptation", " Emotional Regulation", etc).
Boolean operators (AND, OR), adjacency operators (ADJ, NEAR), and truncation (*) were applied as appropriate for each database. The final search strings were tailored individually to database-specific syntax to optimize retrieval.

All articles retrieved from the database searches were exported into EndNote 25 to remove duplicates and to facilitate the screening process. The screening process is conducted in a two-stage procedure: (1) Title and Abstract Screening and (2) Full-Text Screening. This is achieved by identification of records by 2 independent reviewers, adhering to the eligibility criteria by using Rayyan. Studies that did not meet the inclusion criteria were excluded at this stage.
Any disagreements at either stage were resolved through discussion, and if consensus could not be reached, a third reviewer was consulted. A PRISMA-ScR flow diagram was used to document the number of records identified, screened, excluded, and included.

Eligibility criteria • Inclusion criteria
1) Medical students at undergraduate, across pre-clinical and clinical training, in medical schools, colleges, clerkships, or equivalent programs.
2) Digital fatigue and related constructs, including but not limited to technostress, Zoom fatigue, videoconference fatigue, online exhaustion, and virtual learning burnout.
3) Association of digital fatigue to mental health such as psychological well-being, emotional regulation, psychological adaptation, mental resilience, or related indicators.

4) Consequences of digital fatigue on medical students' physical, psychological, social, or academic development and performance.
5) Research employing validated or adapted instruments, assessment tools, or analytical approaches to evaluate digital fatigue and associated mental health outcomes.
6) Peer-reviewed journal articles, including randomized controlled trials, experimental studies, observational studies, cohort studies, pre–post evaluations, survey-based studies, pilot studies, and feasibility or acceptability studies.
• Exclusion criteria
1) Populations other than medical students (e.g., nursing students, other healthcare or non-health disciplines, residents) were excluded.
2) The type of digital device or platform was not a basis for exclusion, but the study needed to involve digital technologies linked to learning or academic activities.
3) Studies with no direct or indirect focus on digital fatigue or related constructs (e.g., technostress, Zoom fatigue, screen fatigue) were excluded. Studies focusing solely on internet addiction, mobile device addiction, telerehabilitation, general digital health technology, or purely visual learning without assessing fatigue were also excluded.
4) Studies that focused on outcomes not identified in the inclusion criteria, such as stress or burnout not attributable to digital exposure, or purely affective evaluations of digital teaching methods, were excluded.
5) Studies in which digital fatigue was not assessed in real-world academic or learning environments (e.g., lab-only experiments without educational context) were excluded.
6) Theses, dissertations, non–peer-reviewed literature, review articles, opinion pieces, protocols, and laboratory experiments without student involvement were excluded.
7) Methodological quality was not used as a basis for exclusion.

Source of evidence screening and selection
The following electronic databases will be systematically searched: Embase, Ovid MEDLINE, CINAHL, and Web of Science. Search results will be exported into EndNote 25 to facilitate the documentation process. Screening will occur in two stages via Rayyan: (1) title and abstract screening, and (2) full-text screening.

Two independent reviewers will evaluate each record against the predefined inclusion and exclusion criteria. Any discrepancies between reviewers will be resolved through discussion, and if consensus cannot be reached, a third reviewer will be consulted. For studies with incomplete reporting or unclear data, the original authors will be contacted via email for clarification. The entire screening process, including the number of articles identified, excluded, and included, will be documented using a PRISMA-ScR flow diagram to ensure transparency.

Data management
Data extraction will be conducted independently by two researchers. Any disagreements during extraction will be resolved through discussion with a third researcher to ensure accuracy and consistency. Extracted data will include:

1) Study characteristics: author, year of publication, country/countries, and study design
2) Population details: medical student year, sample size
3) Mental health outcomes: stress, anxiety, burnout, academic exhaustion
4) Key findings relevant to the study objectives

This systematic approach will allow for consistent collection, management, and synthesis of relevant data across all included studies, facilitating a comprehensive mapping of evidence on digital fatigue in medical students and its associations with mental health outcomes.

Reporting results / Analysis of the evidence
The findings will be presented using descriptive statistics alongside a structured narrative synthesis. Descriptive statistics will be employed to summarize data such as publication year, publication type, and country or countries of origin, reporting frequencies and percentages. Content analysis will be applied to extract and organize the main purposes and key concepts from the included studies. The overall results will then be synthesized and presented in a coherent narrative summary, highlighting patterns, themes, and insights across the literature.

Presentation of the results
The findings will be presented using tables and figures to enhance clarity and accessibility. Tables will systematically display the extracted data, facilitating comparison across studies, while figures will visually highlight key trends, patterns, or relationships. This approach will provide a clear and organized overview of the results, supporting a coherent narrative synthesis.

Language restriction
Article published in English.

Country(ies) involved
Malaysia, Taiwan, Sri Lanka.

Other relevant information
No.

Dissemination plans This review will be submitted to reputable peer-reviewed journals to reach the broader academic community. Findings will also be shared in faculty seminars, presented at the campus summer project showcase, and may be disseminated through academic conferences or workshops to engage educators, researchers, and stakeholders in medical education and digital learning.

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