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Research article

Medical education competency frameworks for climate and planetary health: A scoping review

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ABSTRACT

Introduction: Climate change threatens human health by exacerbating existing health inequities, increasing climate-related illnesses, and disrupting healthcare systems. Preparing future physicians to address these challenges is essential for resilient healthcare systems. While climate health education in medical schools is gaining traction globally, its integration remains inconsistent, with limited consensus on core competencies.
Methods: A systematic search of peer-reviewed and gray literature was conducted across databases including PubMed, ERIC, EMBASE, and CINAHL. Inclusion criteria required frameworks to address climate or planetary health in medical education and to reflect consensus-level guidance from national or regional bodies. Each framework was thematically assessed for competencies and domains.
Results: 12 frameworks met inclusion criteria. Key competencies identified varied among the frameworks and included medical knowledge of climate change's health impacts, skills in climate-informed clinical practice, advocacy for sustainable healthcare, and addressing health equity. Unique aspects of climate health, such as Indigenous knowledge and environmental justice, appeared in a few frameworks. While foundational knowledge was universally emphasized, domains such as health system sustainability and interprofessional skills were less consistently integrated.
Conclusion: Our findings underscore the paucity of globally aligned, evidence-based competency frameworks, especially in the Global South, needed to equip future physicians with the skills to address the health impacts of climate change. Establishing standardized competencies will support consistent education and preparedness among future physicians worldwide. This review reveals a need for standardized frameworks to ensure comprehensive climate-health education across diverse medical education systems. Current frameworks demonstrate progress, yet gaps remain, especially in practical, action-oriented skills and specific competencies for vulnerable populations.

1. Introduction

Climate change poses serious threats to human health and well-being by exacerbating existing health inequities, disproportionately affecting vulnerable populations, altering the social and environmental determinants of health, and damaging health-supporting infrastructure. These challenges include the rise in climate-related health issues, such as heat-related illnesses, vector-borne diseases, respiratory conditions exacerbated by pollution, mental health disorders, and the increasing frequency of extreme weather events that disrupt healthcare delivery [1,

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2]. Preparing future physicians to understand, mitigate, and respond to these health impacts is essential for the sustainability of healthcare systems and the well-being of populations across the globe.

Given the global crisis, climate education in health institutions is on the rise. A recent survey of schools of public health, conducted from November 2023 to March 2024, involved 279 public health institutions across 82 countries and assessed how institutions are educating students on climate and health issues. Of the respondents (196 institutions), 70 % reported offering climate and health education. 39 % of the institutions include climate and health education as a mandatory component, mostly through master's degree programs. There were significant regional differences in the availability of climate and health education with institutions in Europe and the Americas offering the most climate education [3]. Significant progress has also been made integrating content in medical schools. Many individual medical schools have developed climate health curricula, in large part due to medical students [4–11]. Additionally, national and regional medical organizations, such as the Association for Medical Education in Europe (AMEE), have called for inclusion of climate and planetary health, as well as sustainable healthcare education into medical curricula [1,2,12–16].

Despite growing awareness of this need, climate, and planetary health education remains inconsistently incorporated into medical curricula. A 2020 survey conducted by the International Federation of Medical Students' Associations (IFMSA) revealed that approximately 15 % of 2817 surveyed medical schools worldwide are actively educating students on the impact of climate change on health and healthcare delivery [17]. In a 2022 American Association of Medical Colleges (AAMC) survey, 55 % of U.S. medical schools self-reported that climate health content was included in their curriculum [18]. Additionally, medical students often report having received inadequate education on climate health topics and felt ill-prepared to manage climate health concerns in patient care, suggesting curriculums are often inconsistent and insufficient, and gaps remain between the aspiration to integrate climate content and the capacity to do so due to competing institutional priorities [7]. It remains unclear how many degree-granting institutions are systematically incorporating climate-health education into their curricula, and to what extent students are gaining the necessary competencies across different domains of climate and health knowledge. This highlights a significant gap in the education of future healthcare professionals at a time when climate change is recognized as one of the greatest public health threats of the 21st century [19].

This scoping review aims to explore the breadth and depth of competency frameworks related to climate and planetary health in medical education. Specifically, it will address two key questions: 1) What consensus-level frameworks for medical education on climate change and planetary health exist internationally? and 2) What do these frameworks include as essential competencies for climate-health education in medical schools? The findings will help define the current landscape, inform the development of consensus-driven frameworks, and support the integration of climate-health education into medical curricula globally. The results of this review will complement Lancet Indicator 2.2.6, an indicator for climate health education in schools of public health, and will inform development of an international survey to be included in future Lancet Countdown reports to assess curricular structures for climate and planetary health at individual medical schools [20].

2. Methods

2.1. Search strategy

A systematic approach was adopted to search the medical literature and gray literature for competency frameworks on climate and planetary health in medical education, as many of the frameworks are not in the peer-reviewed literature. Frameworks had to be in English or translatable into English. The search process was conducted in two phases: [1] a hybrid search strategy of peer-reviewed medical literature databases, performing systematic searches in the aforementioned digital databases and then snowballing from all the relevant sources found in the previous searches, and [2] a targeted search of gray literature sources with complementary assessment of pre-defined organizational websites (listed below).

2.2. Search of medical literature

An extensive search of peer-reviewed medical and educational literature using the following databases was conducted:

- PubMed/MEDLINE: This was the primary database used due to its comprehensive coverage of biomedical and health-related literature.
- Education Resources Information Center (ERIC): ERIC was included to capture educational research relevant to medical training.
- Excerpta Medica dataBASE (EMBASE): As an additional medical literature database, EMBASE helped to ensure a more exhaustive coverage of international publications.
- Cumulative Index to Nursing and Allied Health Literature (CINAHL): Given its focus on allied health professions, CINAHL was included to capture any relevant competency frameworks that may apply to interprofessional education in climate and planetary health.

The search terms included a combination of Medical Subject Headings (MeSH) and free-text keywords, tailored for each database. The following terms were employed: "Medical education" AND "competency framework," "Medical curriculum" AND ("climate change" OR "planetary health"), "Environmental health" AND "medical education." Boolean operators refined the search and ensure that both broader terms (e.g., "environmental health") and specific terms (e.g., "climate change") were covered.

2.3. Search of gray literature

Gray literature was identified as a critical source for this review because of the evolving nature of climate and planetary health education. Many organizations, government agencies, and non-governmental organizations (NGOs) are actively developing frameworks outside of traditional academic publishing avenues.

The following sources for gray literature were searched:

- Global Health Organizations: Reports and frameworks from organizations such as the World Health Organization (WHO), United Nations (UN), and the Global Climate and Health Alliance were reviewed.
- Medical Associations: Publications from professional bodies such as the American Medical Association (AMA), Association of American Medical Colleges (AAMC), the General Medical Council (GMC), and International Federation of Medical Students' Associations (IFMSA) were examined for relevant guidelines or competency frameworks.
- NGOs and Advocacy Groups: Websites and reports from NGOs working at the intersection of health and climate, such as Health Care Without Harm, were also searched for competency-based materials.
- Educational Institutions: Any publicly available curriculum frameworks developed by medical schools or universities with established climate and planetary health initiatives were included, though frameworks limited to individual educational institutions were excluded.

Outside of the search strategy, the authors reviewed medical school accreditation bodies by searching additional directories including World Directory of Medical Schools (full list of all medical schools in the world – includes contact information), World Medical Association, Foundation for Advancement of International Medical Education and Research

(FAIMER), World Federation for Medical Education (WFME). Additionally reviewed regional medical school accreditation bodies included American Association of Medical Colleges (AAMC) and international equivalent organizations such as the National Authority for Quality Assurance and Accreditation in Education (NAQAAE), the Japanese Ministry of Health, Labour, and Welfare, the Australian Medical Council (AMC), the Saudi Commission for Health Specialties (SCFHS), the South African Medical Association (SAMA), the Medical Council of India (MCI), the General Medical Council (GMC), and the Royal College of Physicians and Surgeons of Canada (RCPSC) [21–24].

2.4. Inclusion criteria

For inclusion in the study, the framework had to have come from a medical school (MD, DO, MBBS) and reflect society-level or national-level guidance or consensus-level country or regional frameworks. The reports had to present a competency framework or curricular guidelines related to climate change, planetary health, or environmental health and be published between 2010–2024 to reflect recent developments in climate and health education.

2.5. Exclusion criteria

Exclusion criteria included frameworks unrelated to medical education or lacking explicit reference to climate, planetary, or environmental health; articles that only briefly mentioned climate change without providing a structured competency framework; and duplicates or documents that did not provide substantive information on competencies. Frameworks employing in single educational institutions were excluded. The search was limited to medical schools training physicians and excluded other health professions schools, such as nursing and medical school-specific guidance.

3. Screening and data extraction

After retrieving all relevant documents, duplicates were removed. Titles and abstracts were screened by two independent reviewers to assess relevance. Discrepancies were resolved by a third reviewer. For sources that passed the initial screening, a deeper assessment was conducted with initial data extraction into a spread sheet based on the following characteristics.

- Category: This included guides and toolkits, lesson plans/modules, climate curriculum paper, case studies, and articles.
- Source of Framework: Whether the framework was developed by medical organizations/societies, academic institutions, governmental organizations, or NGOs.
- Competency Domains: Major areas of knowledge, skills, and attitudes in climate and planetary health.
- Learning Objectives: Whether the competencies were aimed at undergraduate medical students, postgraduate trainees, or practicing physicians.
- Overlap with existing requirements
- Country of origin

Additional notes were taken on specific characteristics of the resource that were not captured with the above criteria.

4. Data synthesis

The extracted data were synthesized to map the landscape of existing competency frameworks. After compilation and synthesis of data, three authors (EC, HW, SW) separately assessed all frameworks, developing composite categories and themes. We then categorized the frameworks according to competency domains (e.g., clinical skills, environmental justice, health advocacy). Consensus was reached among four authors (EC, HW, SW, CS) on final category designations and groupings. There were no significant differences in themes identified but categorical nomenclature was refined.

5. Results

After exclusions, 12 frameworks met the inclusion criteria and were assessed based on a priori criteria (Fig. 1, Table 1). The review identified a diverse range of competency frameworks, though many were found in gray literature sources rather than peer-reviewed journals. Table 2 outlines the documents selected for inclusion and their unique competencies.

Three frameworks [Canadian Federation of Medical Students - Health and Environment Adaptive Response Task force (CFMS - HEART), Planetary Health Report Card (PHRC), Education for Sustainable Healthcare] specified where there was overlap between climate health education and existing organ-based or specialty-based curricula. The CFMS - HEART and Planetary Health Educational Competencies lay out the following areas in the medical curriculum: Social determinants of health, Medical ethics, Global health, Refugee health, Family medicine, Geriatrics, Pediatrics, Health systems science, Population health, Infectious disease, Indigenous health, Nutrition, Water-borne diseases, Dermatology, Cardiovascular disease, Psychiatry, Preventative health, Public health, Occupational health, Obstetrics and gynecology, Communication, Health advocacy, Disaster preparedness, Emergency medicine, Wilderness medicine, Urology, Nephrology, Health of people with disabilities. In Education for Sustainable Healthcare, there was defined overlap with the following categories: Gerontology, Dermatology, Otolaryngology, Ophthalmology, Rheumatology, Neurology, Emergency medicine, Women's care, Pediatrics, Psychiatry, Surgery, Anesthesia, and Global health. PHRC is structured to embed questions within existing organ-based or system-based courses. (Table 1, "Overlap with existing requirements")

After categorization, the authors grouped themes into larger domains (Table 3). Several key competency domains emerged, including:

- Knowledge of climate change's impact on health.
- Skills in climate-informed clinical practice.
- Advocacy for sustainable healthcare systems and for broader societal changes.
- Ethical and social accountability in the face of climate health disparities.

The domain of medical knowledge appeared throughout every framework though some provided more granular details, such as the topics to be reviewed and some took a higher-level approach. Although there was significant overlap among the frameworks, some themes appeared uniquely in only a few of the guidance documents (Table 2, Appendix A). For example, recognition of our interconnection with nature was specifically acknowledged in the Planetary Health Educational framework and appreciation for Indigenous knowledge appeared in the PHRC. Some competencies such as clinical practice, communication, and professionalism were not consistently included in the frameworks, although they may be considered foundational elements of climate health. Scholarly inquiry was only reported in the PHRC and did not appear in other frameworks as a priority element. Overall, the PHRC and Lancet Planetary Health were the most inclusive frameworks reviewed.

6. Discussion

Medical societies and organizations are increasingly calling for substantive integration of climate change education into medical curricula to help future physicians understand and implement sustainable healthcare practice. AAMC has instituted many initiatives to accelerate climate health and healthcare sustainability in educational institutions [25]. In Germany, the Institute for Medical and

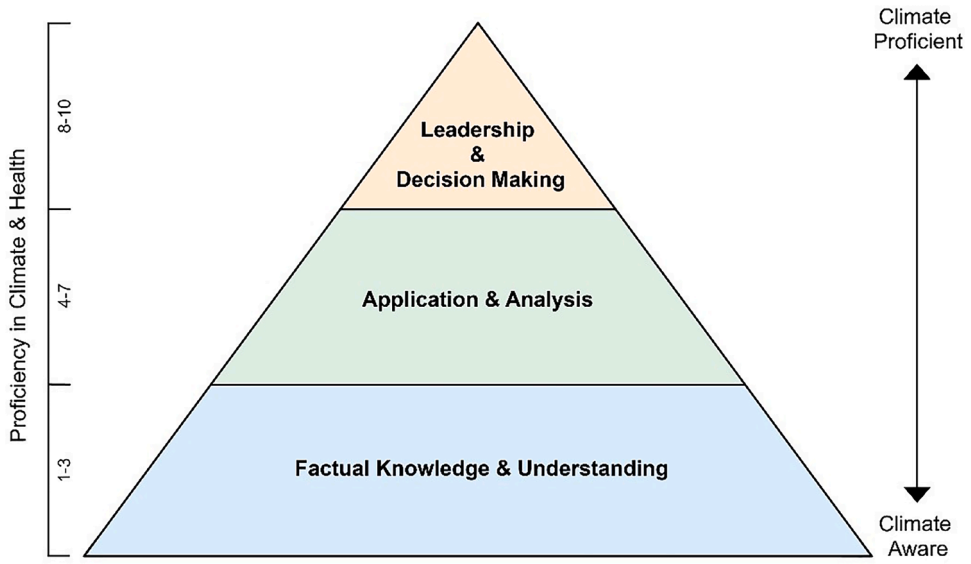

Fig. 1. Schematic 10-point scale for proficiency in climate and health.

Table 1
Characteristics of included frameworks.

Type of organization	Organization	Country of origin	Overlap with existing requirements
Non-governmental professional organization	Global Consortium for Climate and Health Education (GCCHE) [35]	United States-based but global	No
	Planetary health educational framework* [31]	Global	No
	Education for sustainable healthcare [37]	United Kingdom	Yes
	Lancet Planetary Health [30]	United Kingdom	No
	National Planetary Health learning objectives for Germany [38]	Germany	No
	Planetary Health Report Card, Medicine [41]	Global	Yes
	AMEE Consensus Statement [43]	Global	No
	General Medical Council [44]	United Kingdom	No
	CFMS HEART [36]	Canada	Yes
	Medical Schools Council [39]	United Kingdom	No
Medical student organization	Medicine for a Changing Planet** [40]	United States	No
	Australian Medical Council [42]	Australia	No

* Within the Planetary Health Alliance.
** A joint project of the University of Washington and Stanford University.

Pharmaceutical Exam Questions (IMPP) is developing a blueprint for climate and planetary health integration into medical examinations [26]. In The Netherlands, work to create a roadmap for integration has supported institutions incorporating content [27]. The American Academy of Pediatrics has emphasized the importance of educating trainees on the impacts of climate change on children's health, highlighting the need for physicians to be prepared to address these emerging health challenges [28]. Medical societies have advocated for integration of climate and planetary health content into medical education [29].

As global health organizations, medical societies, and academic institutions call for greater integration of climate-health education, frameworks for competency in this area are emerging, with initiatives from organizations like the World Health Organization, the Association of Schools and Programs of Public Health (ASPPH), and the Association for Medical Education in Europe (AMEE) advocating for this educational shift along with dedicated groups such as the Planetary Health Alliance [30,31]. However, a comprehensive understanding of the landscape of climate-health competency frameworks is still needed in medical education. This understanding is crucial to developing standardized best practices in climate-health curricula development that ensure physicians are prepared to address the health impacts of climate change.

6.1. *Overview of frameworks*

This scoping review highlights the competency frameworks that exist and which competencies are represented in regional guidance for medical education. While we identified several frameworks, many are still in early stages of development and even fewer have undergone rigorous peer-review, highlighting the need for global collaboration and further research to establish best practices in climate change and health and planetary health curricular development that can be adopted across diverse medical education systems. Thematic review of content revealed that, while some frameworks took a more comprehensive approach, most focused on specific topical areas and many did not include key areas of medical education such as clinical care, communication, and professionalism. However, additional novel competencies were often included such as those acknowledging the importance of other ways of knowing and those promoting advocacy, equity, and health policy.

6.2. *Distribution of frameworks*

There was overrepresentation of medical education frameworks from the Global North, similar to that found in the survey of schools of public health [3]. This bias may in part be due to the requirement that frameworks be in English or translatable into English, but it may also suggest that under-resourced educational settings in areas more vulnerable to climate impacts are the least able to educate their physicians on climate health. Thus, unequal access to the content may exacerbate health disparities between the Global North and South.

Table 2
Domains in frameworks.

Source document	Medical knowledge	Clinical practice	Communication Skills	Professionalism and leadership	System-based practice	Scholarly inquiry, Quality improvement	Health partnerships, Interdisciplinary approach	Policy/ Advocacy	Equity/ health justice	Sustainable and resilient clinical practice	Other ways of knowing and nature-based solutions (Indigenous knowledge)
Global Consortium for Climate and Health Education											
	X	X	X				X	X			
Canadian Federation of Medical Students (CFMS) - Health and Environment Adaptive Response Task force (HEART)											
	X	X							X	X	
Planetary health educational framework											
	X				X			X	X		X
Education for sustainable healthcare											
	X			X				X		X	
Lancet Planetary Health											
	X		X	X	X		X	X	X		
National Planetary Health learning objectives for Germany											
	X				X			X			
Medical Schools Council											
	X				X				X		
Medicine for a Changing Planet A joint project of the University of Washington and Stanford University											
	X										
Planetary Health Report Card, Medicine											
	X		X	X	X	X	X		X	X	X
Australian Medical Council											
	X	X		X			X	X			
International Association for Health Professions Education (AMEE) Consensus Statement											
	X			X				X	X	X	
General Medical Council											
	X			X				X	X	X	

6.3. Characteristics of frameworks

Perhaps not surprising in an assessment of medical school competencies, all the frameworks included medical knowledge prominently among their competencies. Foundational to the practice of medicine, medical knowledge undergirds all the reviewed frameworks assessments, aligning with traditional education models. The Lancet public health school survey suggested that, while many institutions teach climate and health, the focus is often on imparting factual knowledge, with less emphasis on decision-making and practical action-oriented skills, which are critical for implementing and operationalizing public health interventions [32].

The next most cited competencies, a focus on policy and advocacy (67 % of frameworks), represent more novel competencies outside of traditional educational settings. Other competencies not commonly assessed in undergraduate medical education are equity and health justice (7, or 58 %, frameworks) with a focus on the environmental and social determinants of health. Professionalism as a cornerstone of the profession was present in 6 (50 %) frameworks.

Unique to climate health, a focus on sustainability in health care delivery with resilient health system infrastructure appeared in 5 (42 %) frameworks. This competency acknowledges that the practice of medicine will need to adapt and change in response to climate disasters and its associated supply chain disruptions, along with impacts on patient care. Additionally, the sizable carbon footprint of healthcare activities is incongruent with healthcare's precept to do no harm. Thus, responsible healthcare management requires an understanding of principles of healthcare sustainability and effective resource management, a skill that should be first introduced in medical school and reinforced throughout residency.

A comprehensive climate health education framework should include all essential competencies to ensure future physicians are fully prepared to address climate-related health challenges. Climate health implications of clinical care and effective communication skills were omitted from many of the frameworks, though these are obviously critical elements of the practice of climate health. While their exclusion may represent an assumption that they would be included if knowledge and other skills were in place, these important competencies should be explicitly included in frameworks to be inclusive of all relevant and to avoid inadvertent oversight of important curricular content. Scholarly inquiry, including research and quality improvement, were also infrequently included. While research to strengthen the knowledge base is needed, some schools may place a lesser emphasis on scholarly output in general and may consider this outside the scope of medical education. However, the competency still brings value to the field and expands the skill set of the trainee. Even if some competencies were infrequently cited, such as Indigenous knowledge, they yet represent important aspects of climate health and provide a more complete picture of the field [33].

6.4. Comparison with survey of public health schools

The competencies among the institutions are overlapping and synergistic but they are not identical. The analysis of international schools of public health employed Jagals and Ebi's framework to evaluate competency levels across eight core domains of climate and public health practice (Table 3) [34]. Population health characteristics, including demographics of populations, appeared prominently among these competencies. These institutions also demonstrated an emphasis on the social determinants of health (SDOH) and community engagement and input. Health system mitigation, adaptation, and resilience to climate and environmental change was also a priority. While effects of SDOH were represented among medical schools by health equity and sustainability efforts that align with mitigation and adaptation, other categories such as inclusion of stakeholder and community input was absent from medical school competencies. Public health schools taught active use of research, tracking, monitoring, and surveillance, while medical schools less frequently included scholarly inquiry as a component. Population-level adaptation was absent in medical school guidance but there was a near-universal understanding that medical knowledge and foundational science is required to understand climate and environmental impacts on health outcomes.

Table 3
Climate health competencies in medical schools and public health schools.

Climate health competencies in medical schools	Climate health competencies in public schools
Foundational medical knowledge and analytical skills to identify the health impacts of climate change.	Fundamental science behind the natural and anthropogenic changes in the environment and associated health outcomes for given exposures.
Management and prevention of the health impacts of climate change through evidence-based interventions and patient-centered care.	Demographics, economic development, technology and other drivers/ activities that create pressures on the climate and environment.
Communication with patients, healthcare teams, and stakeholders about the impacts of climate change on health.	Solicit and receive stakeholder and community input to inform communication strategies, taking into consideration theories of behavioral change and existing cultural and political challenges
Professionalism and leadership to leverage the unique role of the medical professional to promote social transformation and planetary health stewardship.	No correlate in public health schools
System-based practice and systems thinking to address the urgency and scale of planetary health challenges.	Assessment of adaptation solutions at population level with accompanying evaluation of health co-benefits
Scholarly inquiry and quality improvement in order to advance research to address the evolving challenges at the intersection of climate change and health.	Use of research, tracking, monitoring, and surveillance to assess future health risks from climate and environmental change and the adaptive capacity of a system to cope.
Development of interprofessional health sciences partnerships that support collaborative approaches to address clinical and health systems level challenges posed by climate change.	Work collaboratively in transdisciplinary and interprofessional climate and health initiatives
Policy and advocacy skills to implement mitigation and adaptation strategies to minimize the environmental impacts of healthcare, address climate hazards, and deliver climate resilient clinical care.	No correlate in public health schools
Climate impacts on social and environmental determinants of health to improve health equity, social and environmental health justice.	How biological, social, economic and structural determinants of health synergize with climate exposures to amplify health risk and vulnerability for individuals, communities and health systems.
Interconnection of health with nature and other ways of knowing, such as Indigenous knowledge, to inform approaches to health and environmental challenges.	No correlate in public health schools

7. Limitations

Limitations include an overrepresentation of medical schools from the Global North. Additionally, most of the Global South is represented by Australian organizations. When the medical school survey is developed and implemented, informed by this research, it will be in 6 different languages (English, Spanish, French, Portuguese, Chinese, Arabic) to mitigate biased sampling. While we limited our search to high-level, consensus guidelines, inclusion of a concept in an overarching framework does not guarantee that the content appears in individual medical school curricula. Similarly, the robustness of coverage of these complex topics cannot be assessed at the framework level. We did not extract all content from all sites and topical areas, such as longitudinal integration into medical curricula and the evaluation of competency attainment through evaluations. Because we excluded medical school-specific guidance, we may have overlooked valuable documents. However, we sought broad representation of frameworks over individual medical schools which would usually be more limited in scope and impact.

Future directions include development of consensus-driven, inclusive competency frameworks, adopted by the international medical education community, to ensure comprehensive and standardized approach to planetary health education. The more proximate development of a survey directed to the international community of medical schools as part of the Lancet Countdown will further elucidate and refine the current landscape of climate and planetary health education. Research on evaluations and outcomes of these frameworks as well as the more granular learning objectives that undergird them is critical to advance an evidence-based medical education platform.

8. Conclusion

The findings of this scoping review suggest that medical educators and institutions should develop standardized, comprehensive competency frameworks specific to sustainable healthcare, climate, and planetary health to prepare future physicians for the environmental challenges that will increasingly shape health outcomes. While there is alignment on many key areas, such as the need to strengthen medical knowledge in climate and planetary health and apply such knowledge effectively, different organizations prioritize various aspects of the content. Developing more uniform guidance with clear domains and competencies can accelerate the integration of these critical topics into the global medical education community.

CRediT authorship contribution statement

Elizabeth Cerceo: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Hannah N.W. Weinstein:** Writing – review & editing, Visualization, Investigation, Data curation. **Stefan Wheat:** Writing – review & editing, Visualization, Validation, Methodology, Formal analysis, Data curation. **James Sullivan:** Resources. **James Bevan:** Resources. **Cecilia Sorensen:** Writing – review & editing, Visualization, Validation, Supervision, Conceptualization.

Declaration of competing interest

The authors have no conflicts of interest to disclose.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.joclim.2025.100488.

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