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Climate change education in undergraduate medical faculties in Türkiye: a national descriptive cross-sectional study

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Abstract

Background Climate change is increasingly recognized as a critical threat to global health, with growing implications for clinical practice, health systems, and medical education. Medical professionals are expected not only to understand the health effects of climate change but also to engage in mitigation, adaptation, and advocacy efforts. As undergraduate medical education plays a foundational role in shaping future physicians, integrating climate-health content into medical curricula has become an urgent priority. However, the extent of curricular integration, faculty preparedness, and institutional support remains unclear in many countries, including Türkiye. This study assessed the status of climate change education in undergraduate medical faculties across Türkiye, identified perceived barriers and enablers, and explored institutional readiness for future curricular reform.

Methods A national descriptive cross-sectional study was conducted via an online survey distributed to academic leaders in undergraduate medical education across Türkiye. The questionnaire explored curricular integration of climate change and health, perceived effectiveness, faculty preparedness, educational resources, institutional strategies, and barriers to integration. Quantitative data were analyzed using descriptive statistics, and qualitative responses were analyzed through thematic content analysis.

Results Fifty-three faculties responded (response rate: 58.9%). Only 26% reported fully including climate change in their curricula, while 32% indicated partial integration and 42% reported no inclusion. Content was primarily embedded within existing mandatory courses and focused on basic concepts and health impacts. Topics such as climate literacy, mental health, and communication were rarely addressed. Only 5.7% of the respondents had received training on how to teach climate-health content. Institutional support was limited, with few faculties having dedicated structures or student-led initiatives. Perceived effectiveness was low, with 48.4% of respondents rating their current climate education as ineffective. Despite these limitations, over 80% rated climate education as important, and 83% supported the development of a national guidance tool.

Conclusions Climate change education in Türkiye's undergraduate medical programs remains fragmented, underdeveloped, and inconsistently implemented. Despite growing awareness, structural and pedagogical barriers hinder progress. There is an urgent need for coordinated national strategies, faculty development initiatives, and resource investment to ensure that future physicians are adequately equipped to address the health impacts of climate change.

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Trial registration Not applicable. This study was not a clinical trial and did not involve any intervention requiring trial registration.

Keywords Climate change · Medical rducation · Undergraduate · Curriculum

Background

Climate change is one of the greatest global public health challenges, significantly influencing disease patterns, straining healthcare systems, and threatening overall population well-being [1]. The increasing frequency and severity of extreme weather events—such as heatwaves, hurricanes, and floods—exacerbate risks to food and water security, disrupt healthcare infrastructure, and contribute to the spread of vector-borne and respiratory diseases [2, 3]. These impacts not only threaten the health of millions of people around the world but also place an overwhelming burden on health systems, particularly for vulnerable populations. According to the World Health Organization (WHO), climate change is expected to cause approximately 250,000 additional deaths per year between 2030 and 2050, especially in developing countries [4].

In this context, healthcare professionals are increasingly seen as essential agents in climate resilience [3]. Physicians and health workers must be trained to identify, prevent, and manage the health consequences of climate change. Accordingly, medical education must evolve to reflect the urgency of the climate crisis. Integrating climate change into undergraduate medical curricula is not merely an educational upgrade—it is a foundational necessity for ensuring climate-informed care [5]. However, despite global momentum, climate change education remains inconsistently and insufficiently addressed. A global survey revealed that only 15% of medical schools included climate change-related topics in their curricula, underscoring a profound gap in educational preparedness [6].

Although the discourse on climate change and health education is growing, it continues to be dominated by research in high-income, English-speaking countries [7]. Consequently, there is an urgent need for region-specific studies that examine local realities, institutional capacities and sociopolitical contexts. Türkiye — a country uniquely situated at the crossroads of Europe, Asia and the Middle East — faces growing health threats related to climate change, including heat waves, air pollution, vector-borne diseases and climate-induced migration [8]. These complex challenges require contextually relevant strategies in medical education. However, there are few empirical data on the extent to which climate change education is currently embedded in the curricula of Turkish medical schools [9].

This study fills a critical gap by presenting a nationwide, descriptive, cross-sectional analysis of climate change education in medical schools in Türkiye. Unlike many existing studies that focus primarily on awareness and perceptions, this study goes further by examining actual curricular practices, teaching methods, faculty development efforts, institutional structures, and perceived barriers to implementation. In this way, it not only assesses the level of awareness but also provides a comprehensive overview of the pedagogical approaches and structural readiness within Turkish medical education. Most of the literature on climate change and health education comes from high-income, English-speaking countries. With the findings from Türkiye, this study contributes a valuable and context-specific contribution to the global dialog on climate and health education- an essential step toward a more inclusive and equitable planetary health agenda.

Methods

Study design

To systematically assess the integration of climate change education in undergraduate medical programs in Türkiye, this study was designed as a descriptive cross-sectional survey. Given the increasing urgency of climate-related health challenges, evaluating the current status of medical education in this field is essential for identifying gaps and opportunities for improvement.

Study population and sampling

The study population consists of all medical faculties in Türkiye. According to the 2023–2024 data of the Higher Education Institution of Türkiye, 116 medical faculties admitting students exist [10]. However, as the structure and full implementation of programs in newly established faculties may not yet be finalized, only the 90 faculties that had already graduated students were included in this study. At the time this study was designed, no national data were available regarding the prevalence of climate change and health education in undergraduate medical curricula in Türkiye. Therefore, the estimated global prevalence of 15% reported in the most comprehensive international study was used as the best available parameter for the sample size calculation [6]. Although this estimate was derived from an international sample, it was considered the most appropriate reference in the absence of national data. Using this anticipated proportion, together with a 5% margin of error and a 90% confidence level, the minimum required sample size was calculated as 55 medical faculties.

To ensure national representativeness, the Nomenclature of Territorial Units for Statistics (NUTS) was used to distribute faculties across Türkiye's regions [11]. The NUTS classification provides a standardized framework for regional classification and supports the systematic inclusion of institutions from different parts of the country. Accordingly, it was used to guide the regional distribution of the study sample and to enhance its national representativeness [11].

Inclusion and exclusion criteria

To ensure that the data collected reflect informed perspectives on curriculum development and implementation, the study specifically targeted faculty members actively involved in the educational administration of medical schools. This includes deans, vice deans responsible for education, curriculum committee members, and chief coordinators, as these individuals play a key role in shaping and integrating new topics, such as climate change education, into medical curricula.

Faculty members not involved in educational administration and administrative staff without direct responsibilities in curriculum development were excluded from the study. Additionally, medical schools that had not yet graduated any students were also excluded, as their curricula are typically still under development and may not yet reflect practical implementation or institutional experience. This approach ensures that responses are gathered from individuals with decision-making authority and from institutions with active educational programs.

Data collection

Because the aim of this study was to describe the national status of climate change and health education in undergraduate medical education in Türkiye, a study-specific online questionnaire was developed for this national descriptive cross-sectional survey. The survey was designed to assess the presence, implementation, and perceptions of climate change and health education in undergraduate medical curricula in Türkiye.

The questionnaire was developed following a review of the international literature and existing guidance on climate change and health education, including key educational frameworks, competency recommendations, and

institutional evaluation initiatives, such as the Association for Medical Education in Europe (AMEE) Consensus Statement on Planetary Health and Education for Sustainable Healthcare [5], the Core Climate and Health Competencies for Health Professionals [12], the Planetary Health Report Card [13], and the Planetary Health Education Framework [14]. These resources, together with the objectives of the study, informed the development of the questionnaire domains and survey items.

The initial draft was developed collaboratively by the research team and refined through iterative discussions among the authors, including two senior medical education experts with extensive experience in undergraduate medical curriculum development. Because the questionnaire was designed as a study-specific data collection instrument rather than a standardized psychometric scale, a formal pilot study was not conducted. Instead, the draft was reviewed before finalization by five faculty members from different disciplines involved in undergraduate medical education. They reviewed the questionnaire for clarity, readability, comprehensibility, and relevance to the study objectives. Minor wording revisions were made based on their feedback before the questionnaire was finalized.

The final version consisted of both closed- and open-ended questions addressing institutional characteristics, curricular content, faculty training, institutional support, available resources, perceived barriers to implementation, and future plans for climate change and health education. The English language version of the full questionnaire is provided as Supplementary Material (Additional file 1).

The survey was conducted using Google Forms, which was configured to allow only one response per participant. Faculty members and administrators were initially invited via e-mail using their official institutional e-mail addresses publicly available on the websites of the respective medical faculties. The invitation included the study objectives, participation instructions, and assurances regarding the confidentiality of the collected data. To increase response rates, follow-up reminders were sent to nonrespondents. When necessary, additional reminders were also sent through professional communication platforms (e.g., WhatsApp) solely for survey invitations and reminders. Google Forms was used exclusively for survey administration, while WhatsApp was used solely for communication with potential participants. No identifiable personal information was included in the dataset used for analysis. Access to personal data was restricted to the research team, and the data were handled confidentially in accordance with the approved ethical protocol and applicable data protection regulations. The survey remained open for responses between September 2024 and March 2025.

The questionnaire was structured into six conceptually related domains, each addressing different dimensions of climate change and health education in medical schools:

1. Participant and institutional characteristics: This section collected background information about the participants, including their affiliated institution, department, academic position within the faculty, university type (state/foundation), and accreditation status of the faculty.
2. Current curricular integration: This section explored the presence of climate change and health topics in the curriculum, the nature and depth of content, methods of integration, distribution across different academic years, the use of student-led institutional initiatives, and the perceived effectiveness of current educational efforts.
3. Faculty capacity and institutional support: This section examined whether faculty members had access to training on climate change education and the extent of institutional support available to facilitate integration into the medical curriculum.
4. Awareness and perceived barriers: This section explored participants' perceptions of the importance of including climate change topics in medical education and identified the primary barriers hindering curricular integration.
5. Future planning and implementation need: This section focused on whether faculties had any existing or planned institutional strategies to incorporate or expand climate change education and gathered feedback on the perceived usefulness of a guidance tool.

6. Recommendations: This section invited participants to share their suggestions, comments, and proposed actions for enhancing the inclusion of climate change education in undergraduate medical curricula.

Data analysis

Descriptive statistics were used to summarize participant and institutional characteristics, as well as survey responses. Associations between categorical variables were assessed via chi-square tests, with Cramer's V reported as a measure of effect size. The ordinal data were analyzed via Mann–Whitney U tests. The open-ended responses were analyzed via thematic content analysis. Recurring themes were identified through inductive coding, and frequency counts were used to assess thematic prominence. Illustrative quotes were selected to enhance the interpretation of the qualitative findings. All the quantitative analyses were performed via IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). Statistical significance was defined as $p < 0.05$.

Ethical considerations

This study was approved by the Clinical Research Ethics Committee of Acıbadem Mehmet Ali Aydınlar University (approval date: 15 August 2024; decision number: 2024-12/510). Before accessing the questionnaire, participants were provided with an electronic participant information and consent form describing the purpose of the study, the voluntary nature of participation, confidentiality and data handling procedures, and the contact details of the study investigators. Only participants who provided electronic informed consent were able to proceed with the questionnaire.

Participation was voluntary, and no incentives were offered. The questionnaire was administered using Google Forms, and WhatsApp was used solely for survey invitations and reminder messages. Personal data (name, institution, and e-mail address) were collected solely for communication purposes, stored separately from the survey responses, kept confidential, not included in the statistical analyses, and not shared with any third parties. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The authors declare no competing interests.

Results

A total of 64 survey responses were initially collected. After applying eligibility criteria related to data quality and institutional duplication, 11 responses were excluded. The final sample included 53 valid responses, resulting in a response rate of 58.9% based on 90 eligible medical faculties.

Participant and institutional characteristics

Among the participating institutions, 75.5% were state universities and 24.5% were foundation universities. In terms of accreditation status, 51% were fully accredited, 18.9% were reaccredited, 18.9% were undergoing the accreditation process, and 11.3% were not accredited. The respondents primarily held positions related to educational leadership, including curriculum committee members (47.1%), vice deans (28.3%), deans (13.2%), and chief coordinators (11.3%). The majority were affiliated with departments of medical education (34.0%), pediatrics (32.1%), and public health (7.5%). The remaining participants were affiliated with diverse fields including gynecology & obstetrics, anatomy, cardiovascular surgery, family medicine, medical humanities and ethics, microbiology, pediatric surgery, pharmacology, psychiatry, pulmonary medicine, radiology, and emergency or forensic medicine. These were grouped as "Other Departments" in Table 1 for clarity.

Table 1 Characteristics of participating medical faculties and respondents

Characteristic	*n* (%)
University Type	
State	40 (75.5)
Foundation	13 (24.5)
Faculty Accreditation Status	
Accredited	27 (51.0)
Reaccredited	10 (18.9)
In process	10 (18.9)
Not accredited	6 (11.3)
Respondent Role	
Curriculum Committee Member	25 (47.1)
Vice Dean	15 (28.3)
Dean	7 (13.2)
Chief Coordinator	6 (11.3)
Respondent Academic Department	
Medical Education	18 (34.0)
Pediatrics	17 (32.1)
Public Health	4 (7.5)
Gynecology & Obstetrics	2 (3.8)
Other Departments (e.g., Anatomy, Emergency Medicine.)	12 (22.6)

Data are presented as n (%). Percentages are based on the 53 responding medical faculties.

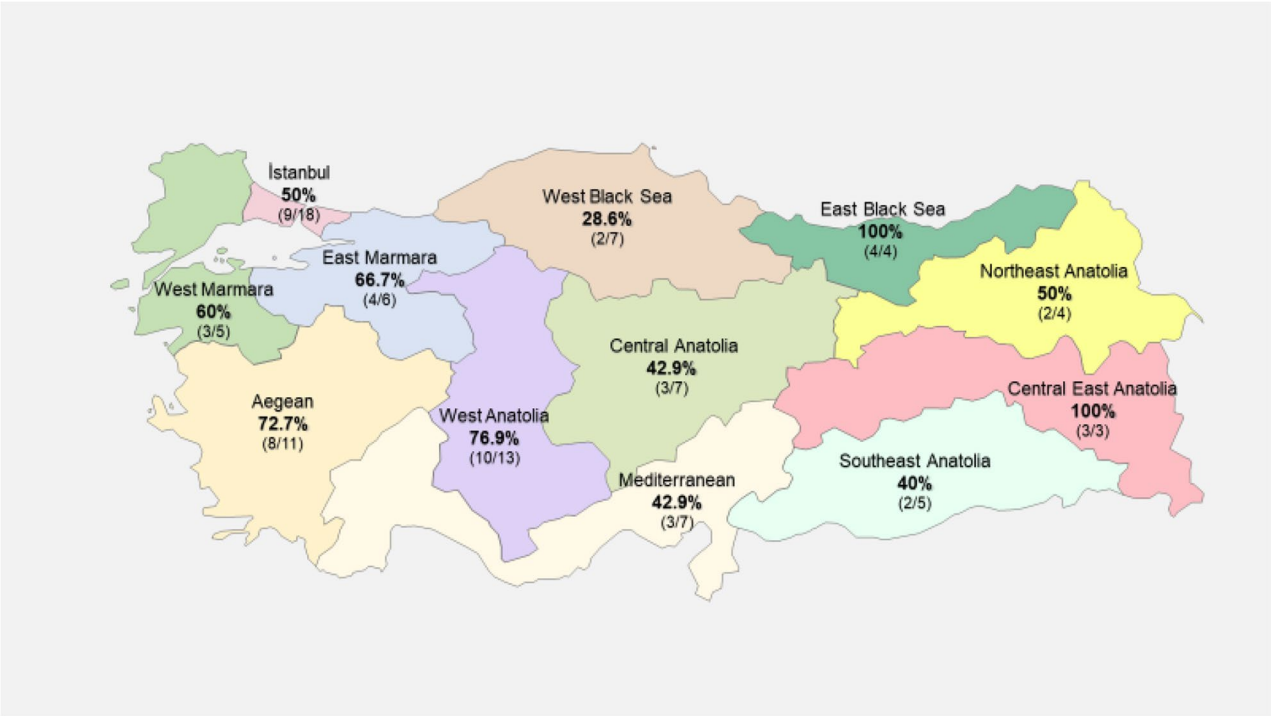

Fig. 1 Geographic distribution of participating medical faculties across the 12 NUTS-1 regions of Türkiye. Numbers indicate the regional response rate (%) and the number of respondents relative to eligible medical faculties. The base map was derived from Eurostat GISCO NUTS 2021 regional boundaries

Regional representation was assessed using the NUTS-1 classification to map the distribution of eligible medical faculties and corresponding survey responses across Türkiye (Fig. 1). Medical faculties were most concentrated in Istanbul, West Anatolia, and the Aegean Region, whereas fewer institutions were located in Central East and Northeast Anatolia. Survey participation also varied by region. The highest response rates were observed in

Central East Anatolia and the East Black Sea (100%), followed by West Anatolia (76.9%) and the Aegean region (72.7%). Low response rates were noted in the Mediterranean, Central Anatolian, and West Black Sea regions (42.9% and 28.6%, respectively). The overall regional response rate was 58.9%. These patterns highlight the importance of geographic diversity in interpreting findings and emphasize the need for regionally sensitive strategies when addressing climate change integration in medical curricula.

Current curricular integration

Climate change education was reported to be fully integrated in 14 faculties (26.4%), partially integrated in 17 faculties (32.1%), and absent in 22 faculties (41.5%). Chi-square analyses revealed no statistically significant associations between the presence of climate change education and either accreditation status (χ^2 [1] = 3.01, p = 0.083, Cramer's V = 0.24) or geographical region (χ^2 [11] = 11.76, p = 0.382, Cramer's V = 0.47).

Among the 31 faculties reporting full or partial curricular integration of climate change and health education, the most frequently covered topics were the basic concepts of climate change (61.3%) and its health impacts (90.3%). Less commonly included topics were climate literacy (12.9%), communication (9.7%), and mental health (16.1%). Climate change and health content was primarily integrated into existing mandatory courses (80.6%), with fewer faculties reporting dedicated stand-alone courses (25.8%), seminars (25.8%), or elective courses (19.3%). Climate change and health topics were most commonly included in the third (61.2%) and sixth (35.4%) academic years (Table 2).

Perceptions of the effectiveness of climate change education vary considerably. While 19.4% of the participants rated implementation as effective (Likert ratings of 4 or 5), 32.2% were neutral, and 48.4% rated it ineffective (ratings of 1 or 2). Mann–Whitney U tests indicated no significant differences in perceived effectiveness based on university type (U = 108.0, p = 0.699) or accreditation status (U = 64.5, p = 0.601).

Table 2 Scope of climate change and health education in integrated curricula (n = 31)

Characteristic	n (%)
Included in Curriculum	
Yes	14 (26.4)
Partially	17 (32.1)
Most Frequently Covered Topics	
Basic concepts of climate change	19 (61.3)
Health impacts of climate change	28 (90.3)
Climate change mitigation and adaptation strategies	10 (32.3)
Climate change policies	8 (25.8)
Interdisciplinary approaches to addressing climate-related health issues	6 (19.4)
Climate change and mental health	5 (16.1)
Climate literacy	4 (12.9)
Climate change and communication	3 (9.7)
Other (Environmental sustainability)	1 (3.2)
Mode of Integration	
Embedded in existing mandatory courses	25 (80.6)
Stand-alone mandatory courses	8 (25.8)
Seminars	8 (25.8)
Elective courses	6 (19.3)
Other (Panels, projects)	2 (6.4)
Years of Delivery	
Year 1	11 (35.4)
Year 2	9 (29.0)
Year 3	19 (61.2)
Year 4	6 (19.3)
Year 5	2 (6.4)
Year 6	11 (35.4)

Results are based on the 31 faculties reporting full or partial curricular integration. Data are presented as number (%). Multiple responses were permitted for topic coverage, mode of integration, and years of delivery

Faculty capacity and institutional support

To explore institutional efforts beyond formal curricula, participants were asked about student-led initiatives, structured programs, and assessment tools related to climate change education. Only 17% of the faculties reported having student organizations or structured activities addressing climate change, whereas 83% had no such initiatives. Similarly, institutional use of the Planetary Health Report Card (PHRC), an internationally recognized tool for assessing and promoting planetary health education, was limited. Only 15% of the faculties reported using the PHRC as part of their monitoring or quality improvement strategies.

Only 5.7% of the participants reported having received formal training on integrating climate change into medical education. A large majority (83%) had not received such training, and 11.3% were unsure.

The participants also evaluated the availability of educational resources at both university and faculty levels (Table 3). At the university level, 22.6% reported resources as sufficient, 39.6% as partially available, 13.2% as insufficient, and 24.5% were unsure. The responses at the faculty level were similar, with 22.6% indicating sufficient resources, 34.0% partial availability, 18.9% insufficiency, and 24.5% uncertainty.

The most frequently cited educational resources for climate change and health education were research articles (58.5%) and textbooks (43.4%). Multimedia resources (35.8%), guest speakers (28.3%), and online modules (15.1%) were used less frequently. Notably, 22.6% of the respondents reported not using any specific resources (Table 3).

Among the 53 medical faculties included in the study, institutional engagement in climate change education showed considerable variation (Fig. 2). Formal partnerships for education or research were rare, and most universities lack dedicated units or coordinators responsible for climate-related initiatives.

Awareness and perceived barriers

As shown in Fig. 3, the majority of participants perceived climate change education as either extremely important (52.8%) or very important (28.3%). No respondent rated it as unimportant.

Despite high levels of perceived importance, several barriers to integration were identified (Fig. 4). The most commonly reported challenge was lack of faculty knowledge ($n=43$), followed by limited curriculum time and low student interest. Other frequently reported barriers included insufficient resources and lack of institutional support. A general lack of awareness was reported least frequently.

Participants were also asked to suggest potential solutions to overcome these barriers. Thematic analysis of the open-ended responses revealed seven key themes (Fig. 5). Faculty training was the most frequently endorsed strategy (74%), with participants emphasizing that “faculty members should be trained and supported to deliver

Table 3 Educational resources for climate change and health education ($n=53$)

Dimension	Response	*n* (%)
Availability of Educational Resources (University Level)	Sufficient	12 (22.6)
	Partially available	21 (39.6)
	Insufficient	7 (13.2)
	Unsure	13 (24.5)
Availability of Educational Resources (Faculty Level)	Sufficient	12 (22.6)
	Partially available	18 (34.0)
	Insufficient	10 (18.9)
	Unsure	13 (24.5)
Types of Educational Resources Utilized	Research articles	31 (58.5)
	Textbooks	23 (43.4)
	Multimedia resources (videos, podcasts)	19 (35.8)
	Guest speakers	15 (28.3)
	Online modules	8 (15.1)
	No specific resources used	12 (22.6)

Data are presented as n (%). Results are based on all 53 participating medical faculties. Multiple responses were permitted for the educational resource types

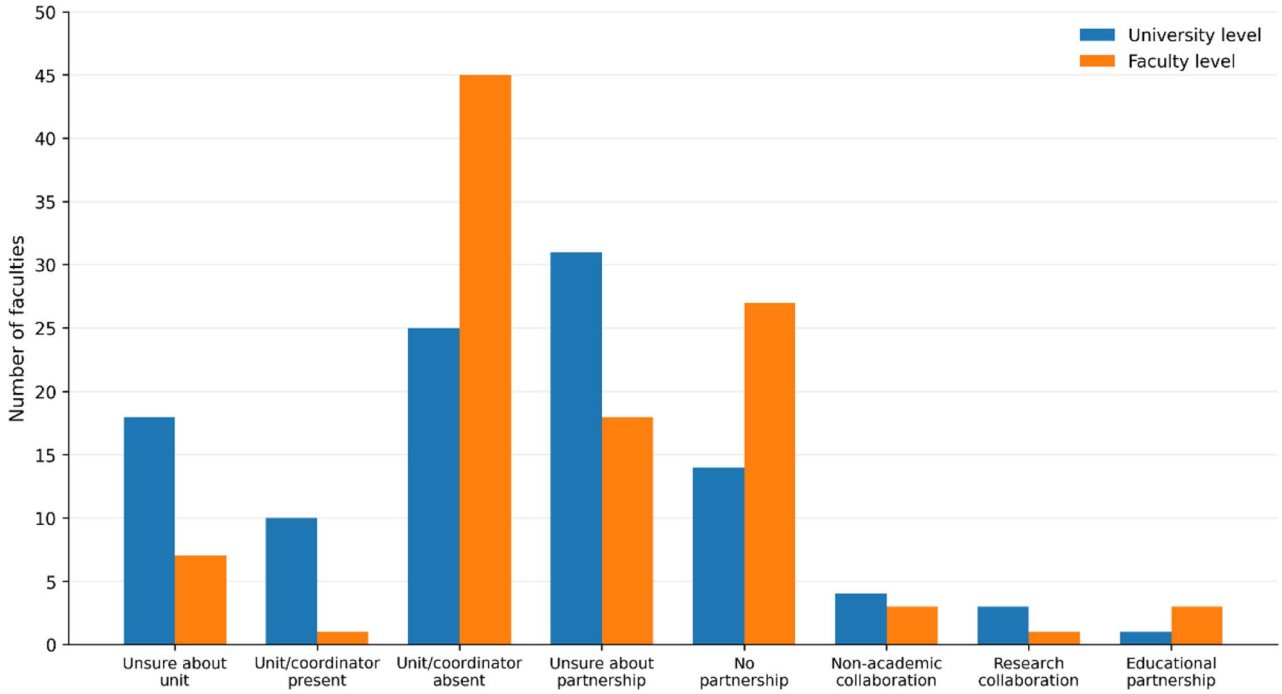

Fig. 2 Institutional partnerships and structures supporting climate change education ($n = 53$). Responses regarding the presence of institutional units/coordinators and partnerships supporting climate change and health education at the university and faculty levels. Data are presented as the number of responding medical faculties ($n = 53$)

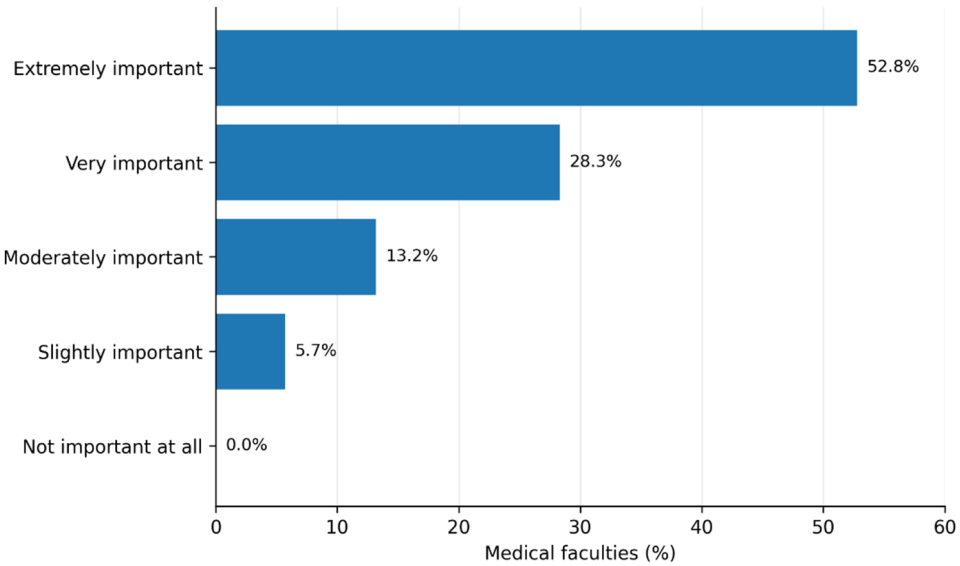

Fig. 3 Perceived importance of climate change and health education ($n = 53$). Responses of the participating medical faculties regarding the perceived importance of climate change and health education. Data are presented as percentages ($n = 53$)

engaging content with videos and visuals." Institutional support was the second most frequently endorsed strategy (60%), reflecting the view that "university leadership must take the issue seriously and develop supporting activities." Just over half of participants (54%) called for curriculum integration, suggesting that "courses related to climate change should be integrated into both preclinical and clinical phases." Smaller but notable proportions highlighted the need for student involvement (37%), with one participant noting that "student groups should be actively supported and involved in awareness efforts," and resource development (34%), as illustrated by the suggestion that "national online training modules, brochures, and multimedia resources could be useful." The least

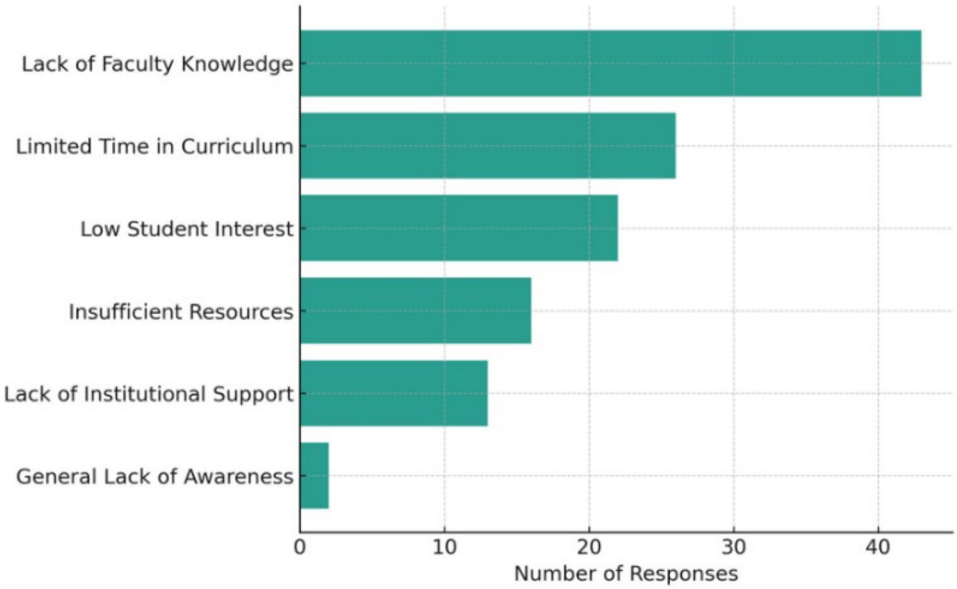

Fig. 4 Reported barriers to integrating climate change and health education ($n = 53$). Reported barriers identified by participating medical faculties regarding the integration of climate change and health education into undergraduate medical curricula. Data are presented as the number of responses ($n = 53$). Multiple responses were permitted

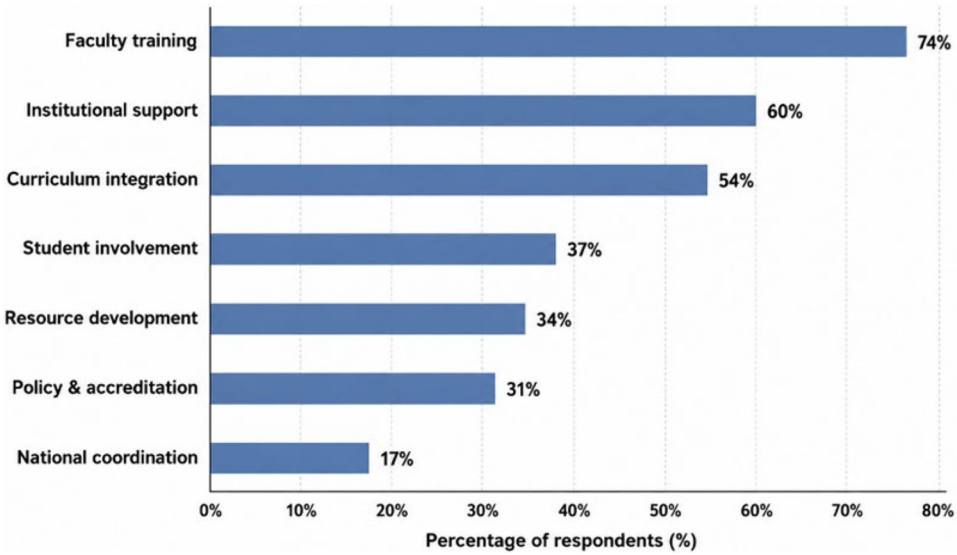

Fig. 5 Themes from participants' recommendations for strengthening climate change and health education (n = 35). Percentages indicate the proportion of participants mentioning each theme. Multiple themes could be identified within a single response

frequently mentioned themes were policy and accreditation (31%), reflected in calls to make "this subject mandatory through national curriculum and accreditation standards," and national coordination (17%), with participants proposing "collaboration and standardization efforts at the national level."

Future planning and implementation needs

Among the 53 participating faculties, only 10 (18.9%) reported having an institutional strategy to incorporate or expand climate change education within their programs, whereas 43 faculties (81.1%) reported no such plans. The reported initiatives varied across institutions and included integrating climate change topics into existing courses and clinical phases, developing elective or dedicated courses, incorporating the topic into research skills training, organizing faculty awareness activities and curriculum panels, strengthening interinstitutional collaboration, and including climate change within broader curriculum revision processes. One faculty also reported plans to establish a dedicated institutional unit in the medium to long term.

Table 4 Illustrative participant quotations on enhancing climate change education in medical schools

Seven representative quotations were selected from 20 open-ended responses to illustrate participants' perspectives on improving climate change and health education

Participant code	Comment
P1	"Our Institute of Social Sciences offers a master's course covering key sustainability issues. Integrating this as an elective into the medical curriculum could be beneficial."
P2	"The impact of climate change on diseases is a crucial topic and should be comprehensively addressed in medical school education."
P3	"Using themes like Planetary Health/Climate Change at Medical Education Conferences could be useful for faculties to share their experiences and good practice examples."
P4	"When treated as a standalone course, climate change can feel disconnected. Integration across learning objectives and assessment is needed."
P5	"Inter-university collaboration is essential for increasing awareness and literacy regarding climate change. Good examples should be shared."
P6	"Programs led by experts for both students and faculty would be beneficial. While some resources exist, more comprehensive materials are needed. A national effort for climate change education in medical schools, supported by frameworks like PHRC, could yield useful outcomes."
P7	"Establishing a climate change collaboration network could facilitate sharing of projects and ideas. Effective communication and joint efforts are essential."

Additionally, the respondents were asked to evaluate the potential usefulness of a national guidance tool to support curriculum integration. The majority (83%) rated such a tool as very or extremely useful. A smaller proportion (9.4%) reported being moderately useful, 3.8% were slightly useful, and 5.7% were unsure. These findings reflect broad support for structured, evidence-informed resources to guide implementation efforts.

Recommendations

In the final section of the survey, participants were invited to provide open-ended comments or additional recommendations regarding the integration of climate change into medical education. A total of 20 of the 53 participants responded to this open-ended question. Thematic analysis of these responses revealed recurring suggestions related to elective course development, interdisciplinary collaboration, integration into learning objectives and assessment frameworks, and the importance of national coordination. Illustrative quotations representing these themes are presented in Table 4.

Discussion

Overview and national context

To the authors' knowledge, this study provides the most comprehensive national-level analysis to date of climate change and health education in undergraduate medical curricula in Türkiye. By capturing the perspectives of institutional leaders, the study provides insight into current levels of curricular integration, institutional readiness, and support across diverse medical faculties. Responses were obtained from 53 of 90 eligible faculties, representing all 12 NUTS-1 regions and providing broad geographical coverage, although response rates varied across regions.

No statistically significant association was identified between geographical region and the presence of climate change education. However, the observed effect size suggests that potential regional variation may warrant further investigation in larger studies. Faculty capacity, local leadership engagement, institutional commitment, and curricular priorities may contribute to this variation [15–17]. Similar institutional variation in the extent and implementation of climate change and health education has also been reported in national studies from other

countries, highlighting the importance of context-sensitive approaches to nationwide curriculum integration in Türkiye [15, 18].

Curriculum integration and perceived effectiveness

Despite growing awareness of climate-related health threats, the integration of climate change into medical curricula in Türkiye remains limited. Only 26% of faculties reported full inclusion, and 32% reported partial inclusion. However, the lack of a standardized definition of "inclusion" in the survey may have led to varying interpretations, introducing subjectivity into these estimates.

Compared with a 2021 review of Türkiye's Bologna course catalogs, which found no references to climate change, these results indicate a positive shift [19]. However, international comparisons highlight significant contrasts: by 2021–2022, 55% of U.S. medical schools had integrated climate-health content into their curricula, up from 27% in 2019–2020, largely due to the support of policy initiatives and advocacy efforts [20]. The published literature on climate-health education has predominantly originated from high-income countries, whereas evidence from the Middle East and Eastern Europe remains limited [21]. Although comparable national studies directly assessing curricular integration are lacking in these regions, available studies provide valuable insight into existing educational gaps. A recent study of medical graduates educated in the Middle East and North Africa reported that only 16.75% had received formal climate change education during medical school, suggesting limited exposure to climate-health education in the region [22]. Similarly, a national study from Iran found that medical students perceived important gaps in their formal education and strongly supported the longitudinal integration of climate change and health throughout the undergraduate medical curriculum [23]. More recently, a national study from Ecuador also reported that climate change remains a low curricular priority in undergraduate medical education, with climate-related content appearing fragmented rather than systematically integrated across the curriculum [24]. In Türkiye, integration remains fragmented, with climate change content often incorporated into existing courses without a clear longitudinal structure or alignment with competency-based frameworks.

Although content on basic climate science and general health impacts is relatively common, topics such as climate literacy, mental health, and communication are underrepresented [25] This imbalance may limit students' ability to grasp the broader, multifaceted implications of climate change for health. For example, climate literacy is essential for developing a comprehensive understanding of the environmental changes that drive health outcomes [26]. However, it remains one of the least addressed topics in curricula, leaving future healthcare providers without the tools to navigate the complexities of climate-related health issues effectively. Similarly, the mental health impacts of climate change, which are becoming increasingly recognized in the global health discourse, are often sidelined in medical training, despite their relevance to the psychological well-being of patients in a warming world [12, 27]. Communication, a critical skill in addressing climate-related health issues with patients and communities, is also frequently omitted from curricula, depriving students of the ability to convey urgent climate-related health information [12, 28].

Integration is achieved primarily by embedding content into existing mandatory courses, often in the third or sixth year. This pragmatic approach runs the risk of providing only superficial coverage of such a critical issue. Without a coherent, longitudinal structure, these topics may lack depth and continuity, ultimately failing to prepare students for the challenges of addressing climate-related health risks in practice. Additionally, the absence of a clear alignment with competency-based learning objectives may result in students not fully mastering the relevant skills and knowledge necessary to manage the health impacts of climate change effectively. This concern underscores the need for more focused and clinically relevant climate change education to ensure that medical students can address climate health challenges in a meaningful and practical way [5, 12].

Notably, 48.4% of the respondents rated their programs as ineffective in delivering climate education, with only 19.4% perceiving them to be effective. This variability, which did not differ significantly by university type or accreditation status, suggests that even where climate content exists, it may lack pedagogical structure, institutional visibility, or measurable impact.

This highlights a need not only for more content but also for pedagogical refinement and outcome evaluation [5, 7].

Faculty capacity and institutional resources

Lack of faculty training emerged as the most significant barrier, with over 80% of respondents reporting no formal preparation. This aligns with global studies identifying educator competence as essential for successful implementation [15, 16]. Without institutional investment in professional development, integration efforts may remain superficial and unsustainable.

In terms of resources, while traditional materials such as research articles and textbooks are widely used, innovative formats—such as multimedia content, guest lectures, or online modules—are underutilized. The planetary health report card, a widely used open-access tool, was employed by only 15% of the faculty. Together with the limited availability of dedicated institutional structures, partnerships, and leadership identified in this study, these findings indicate that institutional support for climate change education remains underdeveloped. Strengthening institutional mechanisms and support systems may facilitate the systematic and sustainable integration of climate change education into undergraduate medical curricula.

Institutional support and student engagement

The findings also revealed that a general lack of institutional infrastructure—dedicated units, coordinators, or student-led organizations focused on climate health-was rarely reported. However, international evidence suggests that student advocacy can be a powerful catalyst for change [13]. Strengthening both top-down institutional commitment and bottom-up student participation is crucial for curricular transformation.

Despite these structural limitations, the level of awareness among faculty leaders is encouraging: over 80% rated climate change education as very or extremely important.

Thematic analysis further emphasized the need for faculty development, cross-phase curriculum integration, and national policy alignment, echoing frameworks such as the Planetary Health Education Framework and the Planetary Health–Organ System Map [14, 29].

Strategic planning and future directions

While only 18.9% of faculties currently report formal plans to expand climate education, several described promising efforts—including elective courses, interdepartmental collaboration, and curriculum revision. These examples demonstrate emerging momentum, but the lack of structured plans in most faculties signals an overreliance on individual champions rather than institutional or national mandates.

The strong support for a national guidance tool (endorsed by 83% of the respondents) reflects readiness to adopt structured implementation strategies. Models from other countries show that tools aligned with accreditation standards can facilitate scalable change [15, 30]. In Türkiye, a tailored toolkit could support curriculum design, faculty training, and institutional evaluation.

Participants also emphasized the importance of interuniversity collaboration, alignment with postgraduate education, and integration into continuing professional development. These perspectives reflect a growing consensus that climate change education must be embedded across the full continuum of medical education.

Limitations

This study has several limitations. First, the reliance on self-reported data may introduce response bias, particularly since the survey did not include standardized definitions for “full” or “partial” curricular inclusion. Second, although the inclusion of faculties from all NUTS-1 regions ensures geographic representation, participation rates varied, and

institutions with greater awareness of climate-health education may have been more likely to respond. Third, while a sample size calculation based on a global estimate of 15% inclusion suggested a minimum of 55 faculties for 90% power at a 5% margin of error, only 53 valid responses were ultimately analyzed. This slight shortfall may have modestly reduced the statistical power, particularly in subgroup comparisons.

Additionally, the study did not include direct document analysis or curriculum content review to validate self-reported data. However, the majority of respondents were deans, vice deans, or curriculum committee members—individuals in leadership roles with authoritative knowledge of curricular structures. As such, the information provided is likely to reflect institutional practices with a high degree of reliability.

Conclusion

This national cross-sectional study demonstrates that the integration of climate change and health education into undergraduate medical curricula in Türkiye remains limited and heterogeneous across institutions. Although awareness of the importance of climate change and health education was high among participants, implementation varied substantially across institutions, with differences in curricular integration, educational resources, and faculty capacity. Faculty knowledge, limited curricular time, and insufficient institutional support were identified as the principal barriers to integration. As members of Türkiye's medical education community, we recognize that progress is underway but also that much remains to be done. While awareness is high and isolated innovations are emerging, climate change education remains uneven, underdeveloped, and unsupported by systemic policy. Moving forward, a coordinated national strategy—anchored in faculty development, curricular resources, accreditation alignment, institutional leadership, and student engagement—will be critical. Strengthening Türkiye's alignment with international planetary health standards is not only achievable but also essential for preparing future physicians for the evolving realities of healthcare in a changing climate.

Abbreviations

AMEE	Association for Medical Education in Europe
IPCC	Intergovernmental Panel on Climate Change
NUTS	Nomenclature of Territorial Units for Statistics
PHRC	Planetary Health Report Card
SPSS	Statistical Package for the Social Sciences
WHO	World Health Organization

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Data availability The datasets used and/or analyzed during the current study are availablefrom the corresponding authors on reasonable request.

Declarations

Ethics approval and consent to participate This study was approved by the Clinical Research Ethics Committee of Acıbadem Mehmet Ali Aydınlar University (approval date: 15 August 2024; decision number: 2024-12/510). Before accessing the questionnaire, participants were provided with an electronic information and consent form describing the purpose of the study, the voluntary nature of participation, confidentiality measures, and the intended use of the collected data. Electronic informed consent was obtained from all participants prior to completion of the questionnaire. Participation was voluntary, and no incentives were offered. Personal data were collected solely for communication purposes, kept confidential, and not shared with any third parties. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

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