



Climate Change in Medical School Curricula: A Status Report

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1 EXECUTIVE SUMMARY

The climate crisis has been declared a significant global health threat and is driving calls for curriculum reform in medical schools around the world. To date, change has been slow and is often led by students, who are advocating for the integration of climate change into their programs, and climate action by their schools. This report documents trends in, challenges to, and case studies on, the presence of climate change in medical education curricula. It concludes that some progress, albeit rather limited given the urgency of the climate crisis, has been made in the last decade. The need to act quickly to avoid irreversible disruption to planetary systems supports a call for more rapid and extensive institutional responses at national, regional and local levels. The slow pace of change in addressing climate change within medical education curriculum must quicken.

2 INTRODUCTION

In 2009, the Lancet identified climate change as the most significant global health threat of the 21st century. According to the Intergovernmental Panel on Climate Change, the next decade will be critical for taking immediate action to avoid “long-lasting and irreversible” risks to humans and ecosystems (IPCC, 2018). From the spread of zoonotic diseases, to increased heat-related illness, to respiratory conditions related to poor air quality, to growing food insecurity, the effects of climate change on health and the determinants of health are becoming increasingly apparent (Fairweather et al., 2020; Kearney, 2020; Philipsborn et al., 2021; WHO, 2005). The health impacts of climate change are disproportionately borne by marginalized people and populations who have contributed the least to rising greenhouse gas emissions, amplifying existing health inequities (Rudolph, L. et al., 2018). However, climate action can lead to significant health co-benefits by preventing illness and addressing determinants of health (Haines, 2017). All of this underscores the imperative to prepare medical students with the knowledge and tools to address the direct and indirect health impacts of climate change.

Many medical bodies, including professional organizations, Faculties of Medicine, and national and international medical student associations, are calling for the inclusion of climate change in undergraduate, graduate, and continuing medical education (AMA, 2019; Hackett et al., 2020; Mercer, C., 2019; Omrani et al., 2020; Walpole et al., 2019). Some go so far as to say that it constitutes “educational malpractice” to exclude the wide-ranging implications of climate change on health and healthcare systems from medical education (Jha, 2019).

To date, there is limited information available that consolidates examples of work being done to advance climate change education in undergraduate and graduate medical education. To add to this literature, the objectives of the following review are:

- To document how medical schools are integrating climate change into curricula;
- To profile specific examples of, and general approaches to, climate change integration in medical school curricula; and
- To provide examples of other mechanisms being used to increase knowledge of climate change and health links among students and faculty in medical schools.

By profiling leaders in curricular reform, we hope to inspire more medical schools to accelerate their efforts to integrate climate change topics into medical education and physician training.

3 METHODS

The report is based on a scan of publicly available online literature, media reports, grey literature and electronic database searches (Pub Med, Web of Science, MEDLINE, Google Scholar), selecting relevant publications and sources from 2016 onward. Limitations of the review include the sole focus on the curricula of medical schools, recognizing that other fields including health research, public health, nursing and non-governmental organizations are also actively engaged at the climate change and health education interface. A focus on publicly available and English language materials means we have not covered all global regions.

The purpose of this report is to provide an overview of progress at a point in time to inform and connect those interested in furthering the integration of climate change into medical school curricula. Because this report relies largely on publicly available information, ethics approval was not sought. However, efforts were made to verify the information presented with affiliated individuals who are acknowledged herein.



4 GENERAL FINDINGS

The interest in incorporating climate change into medical education has increased significantly in recent years and change is often driven by students (Howard, 2019; Marill, 2020; Rabin et al., 2020). In 2017 and 2018, researchers at the Columbia University Mailman School of Public Health surveyed members of the Global Consortium on Climate and Health Education (GCCHE). Of the 59 schools of public health, medicine, nursing, or other health professions that responded, 80 percent reported that “student interest was a factor in establishing or developing curricula on climate and health” (Marill, 2020). When Emory University in the US recently developed and delivered a 4-week online course on climate and health, interest was so high that the lectures were opened to registration across the country, with over 200 students from 30 different institutions participating (Emory Office of Sustainability Initiatives, 2020).

There appear to be several avenues for integrating climate change into medical education (Finkel, 2019; Shea et al., 2020). Some schools focus on climate change as a stand-alone curriculum topic, recognizing the need to provide training on the direct and wide-ranging health implications of a changing climate. Others use a planetary health approach, with climate change as a sub-topic under a broader umbrella of related forms of ecological change and degradation. Fairweather et al. (Fairweather et al., 2020), for example, suggest that climate change “should not be considered in isolation but also other factors of environmental change such as pollution, biodiversity loss and a resulting domino effect from species extinction, pesticide use and land-use change need to be included” to understand how environmental change is affecting human health (p. 2352). A third locus of climate-health education may be found in the global health context, which looks at health issues arising from transnational factors including anthropogenic climate change (Williams & Des Marais, 2016).

Despite high levels of student interest and recognition of the urgency of this topic by professional medical associations, the institutional response remains slow (McLean et al., 2020; Omrani et al., 2020; Wellbery et al., 2018). This is reflected in the results of three global surveys of 2819 schools in 112 countries by the International Federation of Medical Students' Associations (Omrani et al., 2020) that assessed the "integration of formal and non-formal education elements on climate change in the curriculum" (p. 1107). Findings from the survey showed that climate change is taught in only 15% of medical schools worldwide. Up to 22% of schools included a climate and health topic as an aspect of Problem Based Learning (PBL), case learning, or lecture. A full 34% of schools had no aspects of climate and health included in the mandatory or informal curriculum. In 12% of medical schools surveyed, climate health teaching activities were led by students.

Medical schools that have successfully integrated climate change into medical education tend to have committed faculty and/or administrative resources for this work. A significant amount of the available information about these efforts currently originates in the US (Bandyopadhyay et al., 2020). As an example of a successful collaboration with international reach, the Columbia University Mailman School of Public Health (New York) formed the **Global Consortium on Climate and Health Education** (GCCHE) to promote climate change content in health education (including, but not limited to, medical schools).

The list of GCCHE medical school membership may provide one indication of where interest and resources for climate change in medical education are concentrated.

While there is a growing body of literature on the topic of climate change in medical education, detailed information and specific examples of how this is translating into medical school education in practice remain limited. For example, a search of medical school GCCHE member websites in Africa, Asia and Europe to enhance the diversity of case studies presented here did not reveal any available information describing climate change in the curriculum. Based on the findings of this report, this may be because much of this work is still in its infancy (Rabin et al., 2020) and/or has not been publicly documented.





5 CLIMATE CHANGE IN MEDICAL CURRICULA

5.1 Climate Change in a Planetary Health or Global Health Context

Some medical schools are applying a planetary health lens to their education and curricula, with planetary health looking broadly at “how changes to natural systems affect human health and wellbeing at multiple scales” (Pongsiri et al., 2019). At Bond University in Australia, planetary health also explicitly incorporates Indigenous knowledge and perspectives on environmental change and its implications for health (McLean et al., 2020). The imperative to recognize climate impacts is high in Australia as the country is very vulnerable to the immediate effects of climate change in the form of extreme heat, wildfires and cyclones. In 2016, the Medical Deans of Australia and New Zealand (MDANZ), formed a Climate Change and Health Working Group to “develop learning objectives and curriculum resources” (Madden et al., 2018). Proposed amendments to the Australian Medical Council (AMC) Graduate Outcome Statements (GOS) (including specific learning objectives) were distributed to Australian medical schools in 2018. Bond University has now incorporated planetary health across all five years of the undergraduate program (McLean et al., 2020).

Global health within the practice of medicine is focused on improving health and achieving health equity for all populations worldwide. It includes health issues of transnational importance, like pandemics, health security and environmental issues—including climate change. A 2020 study reviewing curricular content of UK global health programs found that broad-level themes were widely present while details about important, emerging areas of concern in global health were missing, including climate change as an emerging topic of significance (Bandyopadhyay et al., 2020). In Germany, a review of the national competency-based learning objective catalogue for medical education similarly revealed gaps in key environmental topics, including climate change (Kreitlow et al., 2021). However, some schools are leading in addressing both planetary and health topics in their curricula. The following are examples of schools that have integrated climate change and health links into their curricula in the context of a planetary or global health approach.

5.1.1 Bond University Faculty of Health Sciences and Medicine (Australia)

Planetary health topics are integrated throughout years one, two, three and five in the undergraduate medical program at Bond University, a signatory to the UN Sustainable Development Goals (M. McLean, personal communication, January 6, 2021). Course content requires year two students to engage in a series of activities over several weeks, incorporating planetary health and sustainable healthcare topics. They prepare student group presentations, which become resources for other students. Using a workshop format, students identify historic, current, and future health issues globally and locally. Climate change is identified as a current health issue which is then discussed in detail including the environmental footprint of healthcare. Using the UN 2030 Sustainable Development Goals (13 SDG+ for Good Health and Well-being), student teams identify an environmental issue impacting on health and well-being, submit a proposal, receive feedback, then work on their “product” for about five weeks.

5.1.2 UC Berkeley/UCSF Joint Medical Program

USCF has a good selection of planetary health elective offerings and some Problem-Based Learning cases include planetary health topics. A *Climate change and health*

course has been part of the undergraduate medical program since 2009. In 2017, the UCSF Medical School Bridges Curriculum (focused on inquiry) introduced a 12-hour course on climate change with learning objectives including the impacts of climate on health, sustainability in health care systems and environmental justice (*Climate Change in the Emory Medical Curriculum – Emory Office of Sustainability Initiatives*, n.d.). The school was identified as a leader in a 2020 Planetary Health Report Card reviewing progress in participating schools. However, to date planetary health has not been integrated into the UCSF core curriculum although a 2020 update from the UCSF Office of Sustainability indicates that some faculty have accessed grants to assist with this integration.

5.1.3 Charité, Universitätsmedizin Berlin (Germany)

The university's medical global health curriculum currently includes some lectures on climate change within the core undergraduate requirements, including one teaching unit on *Medicine and responsibility: Climate change* and two teaching units on *Climate change—impacts on population health and intervention strategies*, where one teaching unit is the equivalent of 45 minutes of lecture time (Schuster et al., 2020).

5.2. Climate Change as a Stand-Alone Curriculum Element

Examples of climate change integration into the medical curriculum provided here originate from the US and Canada, Germany, Columbia, South Africa and Australia. The literature suggests that there are broadly five approaches that schools are using to integrate climate change into curricula, notwithstanding areas of overlap that may occur (Shea et al., 2020):

- 1) Integration or dissemination of climate/health links across the entire curriculum;
- 2) Climate/health topics embedded within mandatory coursework;
- 3) Climate/health stand-alone mandatory courses;
- 4) Climate/health elective courses;
- 5) Clinical modules or case-based learning.

The most common approaches are to embed climate topics within already existing mandatory courses or to offer elective courses focused on climate and health. Relatively few examples of fulsome integration or dissemination across the curriculum exist, though some were identified and are included here.

In the absence of formal curricular elements, there are many examples of student-led or extracurricular faculty initiatives in the form of online learning modules, workshops and conferences that operate in parallel with formal curricula within the undergraduate and graduate medical education system. It is noteworthy that initiatives by students or faculty, or projects undertaken as collaborative efforts, are frequently the catalyst for more formal integration of climate/health topics into medical education curricula.

5.2.1 Integration/Dissemination across the medical curriculum

Integrating or disseminating climate change topics across the curriculum is a way to manage the challenge of expanding crowded medical curricula. Schools have done this by looking for natural links between climate and health topics within existing course material. Examples of existing lecture topics linked to climate change include vector-borne microbial diseases and neurology topics where emerging research is presented, for example linking exposure to particulate matter from car exhaust to neurodegenerative diseases like Alzheimer's (Cayon, 2019).

The Icahn School of Medicine at Mount Sinai in New York and the Emory University School of Medicine in Atlanta, Georgia are two institutions that have taken this approach. Rabin et al. (Rabin et al., 2020) provide a detailed account of the process used to develop proposed climate and health learning objectives to guide the dissemination of content throughout pre-clinical years of the undergraduate medical curricula at Emory University. At the Icahn School of Medicine, the decision to integrate the material into existing coursework rather than having a stand-alone climate module was made to illustrate the myriad interconnections between climate change and health. The University of Minnesota is taking a similar approach, designing decks of four to five slides to insert into existing lectures across the university's health sciences programs (Howard, 2019). While there are still relatively few available examples of full integration across the curriculum, more information on initiatives at the Icahn and Emory Schools of Medicine is provided here.

5.2.1.1 Icahn School of Medicine, Mount Sinai (United States)

The ***Climate Change Curriculum Infusion Project*** (CCCIP) integrates climate change into both medical school and public health programs. The Global Consortium on Climate Change and Health Education (GCCHE) provided a road map for content, which helped develop the curriculum plan. The first class of the first semester is a required course called *The Art of Medicine*, which introduces the CCCIP project and climate change concepts and then integrates climate content across subject areas through the first and second years. Within the course offerings, "climate change concepts and specific health examples enhance didactic content" and are "cross-walked" with medical school competencies (Association of American Medical Colleges, 2019).

5.2.1.2 Emory University School of Medicine (United States)

A disseminated "*Climate Change & Environmental Health*" curriculum for the pre-clinical years was developed in a collaboration between students and faculty mentors and endorsed by the University's Executive Curriculum Committee in 2020. The proposed learning objectives are dispersed across numerous modules within the pre-clinical years; for example, in gerontology and social determinants of health modules.

Work is ongoing in collaboration with the director of the pre-clinical years' curriculum and individual faculty members to implement the proposal for current first-year medical students (class of 2024). As outlined in Rabin et al. (Rabin et al., 2020), specific curriculum objectives guiding the process are: 1) to inform students about the links between climate change and health as they relate to pathophysiology in the pre-clinical years, and 2) to help students investigate root cause by examining structural inequities and healthcare system sustainability through a climate lens.

5.2.1.3 University of Cape Town, Division of Environmental Health (South Africa)

Participating faculty and staff are trying to expand climate change and environmental health topics from inclusion in year four only to all years of the undergraduate program. The School is training course facilitators in "*Becoming a Professional and Becoming a Health Professional*" on environmental health and climate change. Specific examples of integrating climate change content into existing program elements include a year one *Health in Context* course (30-minute lecture on climate change and environmental health, 2019), a year two *Becoming a Doctor* course (working on adding environmental health and climate change into medical expert competencies and identifying where to add environmental health history taking as well as an *Integrated Health Systems* course (case study on climate change and waterborne disease). There is currently a gap in year three, with ongoing discussions on future content. Year four includes a *Health in Context* course (1 hour climate change block, 2 hours on environmental health topics, while year five and six aim at developing environmental health electives for clinical and practical experience (Columbia Public Health, 2019b).

5.2.2 Mandatory courses in climate and health

Examples of medical schools that require students to take mandatory courses in climate and health are limited. In the context of some of the challenges for integrating climate education identified in the literature, the volume of existing material to cover in crowded medical curricula is a likely factor, as are the limitations of staff time and resources for developing entirely new course content.

5.2.2.1 University of California San Francisco, School of Medicine (United States)

The Medical School has offered a *Climate and Health* course since 2009, mandatory for all first-year medical students. The course explores the fundamentals of climate change and impacts on health while introducing students to concepts like environmental justice and the sustainability of health systems (Howard, 2019). Work by the university to encourage and train faculty to integrate environmental sustainability teaching into courses is ongoing, and is being funded by the Office of the President (Columbia Public Health, 2020).

5.2.2.2 Pontificia Universidad Javerian, Faculty of Medicine (Columbia)

The Department of Social and Preventative Medicine is working to develop a stand-alone required course (including a virtual course) focused specifically on climate and health (Caicedo & Li, 2019; Columbia Public Health, 2019a).

5.2.3 Climate and health topics embedded within mandatory coursework

Embedding climate topics within required undergraduate courses and coursework is one of the most common strategies in medical education (Shea et al., 2020). This approach can vary from integrating climate change topics into existing lecture material to delivering stand-alone lectures on climate and health within required courses. Examples of mandatory courses at medical schools follow.

5.2.3.1 *Pontificia Universidad Javerian, Faculty of Medicine (Columbia)*

Second-year students participate in six hours of learning on climate and health in the form of lectures, seminars, and workshops. Fourth-year students participate in a three-week internship, comprising six hours per week on related topics. Specific topics include basic concepts in public health and climate, sources and tools for analyzing public health data, and using climate information in decision-making for climate-sensitive diseases (Caicedo & Li, 2019; Columbia Public Health, 2019a).

5.2.3.2 *University of Western Ontario, Schulich School of Medicine and Dentistry (Canada)*

Following the release of the 2020 HEART National Report on Planetary Health in Canada, the university has made time available to add formal discussion and case learning related to climate change and planetary health into the first-year medical curriculum. A group is working to finalize the first iteration of these cases for rollout in 2021 (G. Tjensvoll Kitching, personal communication, January 23, 2021).

5.2.3.3 *University of Cape Town, Division of Environmental Health (South Africa)*

During the fourth year of the program, students participate in a one-hour session on climate change as well as a two-hour session on environmental health. Specific topic areas covered include basic concepts of climate change, key evidence of global climate change, climate impacts in environmental determinants of health, climate impacts on human health, climate risk, and vulnerable populations (Columbia Public Health, 2019b).

5.2.4 Climate and health elective courses

Many schools integrate climate and health content into medical curricula through elective course offerings. Proponents of a disseminated curriculum model highlight two drawbacks of offering only elective coursework. Firstly, students with knowledge gaps or lack of interest will continue into practice without basic climate literacy, and secondly, an elective approach undermines the urgency of incorporating climate education as foundational knowledge for all future physicians (Rabin et al., 2020). Several examples of existing elective offerings of climate change-focused courses at medical schools follow.

5.2.4.1 *Warren Alpert Medical School at Brown University (United States)*

The medical school offers a *Climate Change & Health Pre-Clerkship Elective* as one of a variety of electives open to first- and second-year medical students. Although listed on the student's official transcript, they do not count toward fulfilling the requirements of the MD degree. Students in the course learn how to identify and address the most salient emerging concerns in the era of climate change. The course provides an overview of the wide-ranging health impacts of climate change (i.e. heat-related morbidity and mortality, changing infectious

disease patterns, and extreme weather events) as well as the impact of healthcare on the environment.

5.2.4.2 Emory School of Medicine (United States)

Climate Crisis and Clinical Medicine Virtual Elective for Medical Students

is an elective offered to third- and fourth-year medical students.

The course is four weeks long, delivered virtually, and includes 17 lectures. Specific topics covered in the course include emerging clinical challenges related to climate change, health equity, climate solutions for the healthcare sector, and communicating about climate change.

5.2.4.3 Penn State College of Medicine (United States)

Penn State offers an elective course on *Climate Change, Health, Healthcare Delivery, and Sustainability*. The two-week course teaches students about the health impacts of climate change, healthcare system response to climate emergencies, healthcare system sustainability and creating an intervention to improve integration of climate change in public health (MS4SF, 2020, p. 4).

5.2.4.4 University of Colorado School of Medicine (United States)

An elective course called Climate Medicine is offered as an intensive two week course and includes field trips. As a fourth-year course, it is designed to build on the foundational knowledge and clinical experience that students gain in the first three years of their program. Specific topics that are covered include: heatwaves and heat illness, extreme weather, vector-borne diseases, mental health, air degradation, water and food security, and vulnerable populations.

5.2.4.5 Stanford University School of Medicine (United States)

A non-credit course delivered as a weekly lunch seminar entitled The Impact of Climate Change on Human Health aims to introduce medical trainees to a variety of climate change topics and advanced clinical skills related to climate change. Specifically, the seminars focus on climate-sensitive disease, sustainable medicine, and climate change advocacy. The course features speakers who are leaders in this emerging domain and also integrates patient perspectives on climate change. Each class session is designed to be interactive, with a mix of “didactic lectures” and group discussion. Optional study materials to support each weekly topic are also provided.

5.2.4.6 Moodle Universität Augsburg (online), Faculty of Medicine (Germany)

The university offers an elective course in the third semester called *Climate and Health*. Content areas of the course included: climate and health basics, data and methods, thermal stress, anthropogenic and biogenic air, vector-borne diseases, and extreme events (University of Augsburg, n.d.).

5.2.5 Integration of climate change in clinical scenarios or case—based learning

The integration of climate change impacts into clinical scenarios has the advantage of using an existing teaching approach to integrate climate change information. For example, the history of a patient with respiratory issues offers the opportunity to link climate with a specific health risk. The University of Illinois College of Medicine in Urbana educators used this approach by adding the topic into existing curricular content for simulated clinical scenarios. A limitation of having a solely clinical focus is that it does not provide students with a comprehensive context for climate change in relation to health and health systems. Examples of schools using case-based learning include the three below.

5.2.5.1 *University of Illinois, Urbana-Champaign College of Medicine (United States)*

Integration of climate change into the third year Internal Medicine clerkship rotation through the use of a simulated encounter. Students participate in a required Observed Structured Clinical Examination (OSCE) simulated encounter where the standardized patient is experiencing exacerbation of her asthma due the effects of climate change related California wildfires (Ramkumar Japhia et al., 2021).

5.2.5.2 *Georgetown University School of Medicine (United States)*

The year three family medicine clerkship includes a focus on asthma through a climate lens. The approach includes a short, integrated climate change module that has students “investigate the connection between air pollution and climate change, identify specific lung irritants, look up current air quality data, and apply recommendations to advise a patient with asthma” (Wellbery et al., 2018).

5.2.5.3 *University of Cape Town, Division of Environmental Health (South Africa)*

Fourth year studies include a two-hour session dedicated to taking an environmental health history. The session includes the identification of environmental health risks in a diagnosis, with consideration for the patient’s socioeconomic status. Students make potential climate links by engaging in role-playing, which considers environmental hazards and how they manifest in symptoms using Kreisberg’s mnemonic (Columbia Public Health, 2019b; Walpole et al., 2019).

5.2.6 Extracurricular approaches

There are many examples of mechanisms outside the undergraduate and graduate curriculum where climate and health links are made for health professionals in training. These include the development of shared online resources, fellowships in climate and health, faculty training and extracurricular specializations in climate and health. Several examples follow to illustrate the diversity of initiatives being implemented.

5.2.6.1 *University of Colorado School of Medicine, Department of Emergency Medicine (United States).*

A ***Climate & Health Science Policy Fellowship*** has been developed by the University of Colorado Department of Emergency Medicine. The unique one- to two-year fellowship includes placements with partner organizations specializing in climate and health research, policymaking, and practice (e.g., the National Institutes of Health, the Centers for Disease Control and Prevention, the TH Chan Harvard School of Public Health). The fellowship is designed to empower physicians as climate and health leaders and to provide training on “climate education, meaningful engagement, and effective communication” (University of Colorado, n.d.).

5.2.6.2 ***Medical Society Consortium on Climate and Health (MSCCH)***

The Medical Society Consortium on Climate and Health (MSCCH) is presently composed of 29 ***member*** medical societies and 53 ***affiliate*** organizations. The Consortium’s goal is to inform decision-makers and the public about the immediate and long-term effects of climate change on health, as well as provide information on preventative and protective health measures. Recognition of the disproportionate effects of climate change on vulnerable populations is part of the effort to improve health equity through climate-based solutions (Medical Consortium on Climate and Health, n.d.).

5.2.6.3 ***Yale University Online Program (United States)***

The ***Climate Change and Health: From Science to Action Specialization*** is a series of three online Coursera courses that are open to the public and taught by Yale faculty at the School of Public Health. The three courses offered as part of the specialization are: 1) *Introduction to Climate Change and Health*, 2) *Climate Adaptation for Human Health*, and 3) *Communication Climate Change and Health*. The courses are designed for health professionals and others who want to deepen their understanding of climate change and its impacts on health. As a whole, the program has an applied focus involving the identification of a location-specific climate-sensitive health issue, the development of an adaptation action to address that issue, and a corresponding communication campaign (Yale University, n.d.).

5.3 Student-led Initiatives

Student-led initiatives continue to be a catalyzing force for curricular change. Initiatives are being led at the institutional, national, and international levels with a focus on both climate change specifically and/or climate change in the context of planetary health. Examples of student-led or faculty/student collaborations include the following examples.

5.3.1 ***International Federation of Medical Students’ Associations (IFMSA), Climate Change and Medical Schools Surveys***

The results of three global surveys encompassing 2817 medical schools in 112 countries were released in 2020. The purpose of the surveys was to assess the

integration of formal and non-formal education elements on climate change in medical school curricula (Omrani et al., 2020).

5.3.2 Medical Students for a Sustainable Future, Guide to Climate and Health Curriculum Reform in Medical Schools

Medical Students for a Sustainable Future (MS4SF) is a network of medical students from 86 medical schools in the US, DC and Caribbean working to raise the profile of the effects of climate change as a significant health and equity issue. MS4SF is advocating for educational reform by working with medical schools to develop core competencies for a climate-health medical curriculum. This includes the production of a 2020 *Guide to Climate and Health Curriculum Reform in Medical Schools*, whose purpose is to provide resources to help advance progress in integration of climate-health curriculum in medical schools (MS4SF, 2020).

5.3.3 Canadian Federation of Medical Students (CFMS) Health and Environment Adaptive Response Task Force (HEART)

CFMS HEART was established in 2016 to help coordinate advocacy by Canadian medical students related to current issues in environmental health and climate change. One of HEART's goals was to incorporate planetary health teaching into all Canadian medical school curricula by 2020. In 2018-2019, the group undertook a national survey to evaluate the status of planetary health concepts in all 17 Canadian medical schools' curricula (Canadian Federation of Medical Students, 2019b).. HEART is also currently developing Planetary Health Educational Competencies with input/review by medical professionals at universities across Canada (Canadian Federation of Medical Students, 2019a).

5.3.4 Planetary Health Report Card (founded at University of California San Francisco)

The Planetary Health Report Card started as a US student-led international collaboration with faculty mentors that evaluates medical schools on the basis of measures in four categories: planetary health curriculum, interdisciplinary research in health and environment, university support for student planetary health initiatives, and community outreach centred on environmental health impacts. The team has expanded to include students from schools in the US, UK, Ireland and Norway. The 2019-2020 pilot scored 12 US and Canadian medical schools, with the second report card published on April 22, 2021 (Earth Day) and reviewing 62 medical schools in the USA, UK, Ireland and Canada (Planetary Health Report Card, 2021).

5.3.5 Stanford Climate and Health, Stanford Medical Students Association (United States)

The Stanford Medical Student Association Climate and Health group is working on a pilot to integrate climate change into pre-clinical classes with support from the directors (A. Jowell, personal communication, December 4, 2020). Among other resources, the group has taken content direction from the "*Guide to Climate and Health Curriculum Reform in Medical Schools*" developed by Medical Students for a Sustainable Future (MS4SF). As of 2020, the School will offer a climate and health elective as the result of a student-led initiative (Howard, 2019).

6 CONCLUSION

Despite the urgent calls to integrate climate change into medical curricula, educational institutions have been slow to respond. The examples presented here suggest that schools in the United States and Australia have taken a leading role in formalizing and disseminating their work and may provide a useful blueprint for others to do the same. In Canada, student initiatives are leading the way in defining core competencies and advancing the climate change and planetary health agenda in medical programs across the country.

Several barriers to progress have been cited in the literature, including a lack of space in the core curriculum (Shea et al., 2020) and a need for more clarity on core competencies. Other challenges include competing institutional priorities or inertia (Malhotra, 2020), along with lack of expertise and/or staff resources within medical school faculties and limited access to suitable teaching materials. Epistemologically, Maxwell and Blashki (Maxwell & Blashki, 2016) also point to “traditional bias towards biomedical reductionist paradigms” and the presumed political nature of climate change as significant remaining challenges to overcome (p. 17).

In a recent GCCHE survey, responding institutions, of which 18% were medical schools, cited lack of available staff time and funding to support curriculum development, followed by competing institutional priorities as the top challenges (Shea et al., 2020). Furthermore, while most member schools are considering adding climate change topics to the curriculum, a majority are considering embedding information within existing coursework or offering elective courses, rather than developing stand-alone lectures or fully integrating climate education across the medical curriculum. While some progress has been made in terms of curricular engagement with climate change and health, specifically with respect to education on health impacts, we have identified gaps in terms of education on climate advocacy (i.e., how to use expertise and influence to advocate for adaptation and mitigation policies that protect and promote health) and communication (i.e., how to effectively communicate climate impacts and solutions). Acknowledging place-specific and regional differences in climate-related health impacts also emphasizes that there is no one-size-fits-all approach to curriculum development (Hansen & Bi, 2017; Maxwell & Blashki, 2016).

Meanwhile, many student groups and universities worldwide are leading the way on curricular reform that reflects the realities that medical school graduates will be facing in clinical practice in the near and distant future. A suite of proposed actions to accelerate the integration of climate change into medical curricula and support the necessary institutional reform are provided in the literature. These address the need to introduce climate change education as a requirement into accreditation standards for regulated medical professions (Shea et al., 2020), identifying gaps and defining core competencies to be integrated into university accredited undergraduate medical programs (Canadian Federation of Medical Students, 2019a; Hackett et al., 2020). It also requires increasing institutional capacity, through improved funding and staffing support for curricular reform (Shea et al., 2020), embedding environmental health scientists and climate experts within medical faculties (Coverdale et al., 2018) and offering incentives to encourage medical school faculty to integrate climate change into course material and medical education (Friedrich, 2017).

In the area of program development, schools can work with faculty to add climate change content, including communication skills, advocacy skills, and patient education and offer training and continuing education to faculty for how to integrate relevant material in medical education (Wellbery et al., 2018). The value of collaboration is also highlighted in the literature, suggesting that schools can co-ordinate with national organizations to assist in the development and standardization of curriculum materials (Philipsborn et al., 2021). Capitalizing on existing professional and institutional networks like the Global Consortium on Climate and Health Education is also recommended for advancing the climate-health agenda and sharing valuable lessons learned (Caicedo & Li, 2019). Additionally, collaborating with and supporting student efforts to advance climate education in medical schools has proven to be one of the most effective pathways for change.

A final pathway that could support more substantive progress in this area is to leverage the growing role and focus on social accountability among medical schools. As outlined by the World Health Organization (Boelen et al., 1995), social accountability is an obligation for medical schools to “direct their education, research and service activities towards addressing the priority health concerns of the community, region, and/or nation they have a mandate to serve”. Social accountability requires medical schools to prepare a fit-for-purpose workforce who can respond to the ever-changing needs of the people and populations that they serve. With global consensus to achieve socially accountable medical education (World Federation for Medical Education et al., 2010) and a commitment by all 17 medical schools in Canada to make social accountability a pillar of the next five years (AFMC, 2021), there is a timely opportunity to synergize climate change and social accountability conversations. The health impacts of climate change and the need for climate action with co-benefits for individual and population health clearly have strong links to social accountability mandates. Moreover, in the context of our rapidly changing climate, it is time for medical schools to recognize and enact social and ecological accountability.

While progress in the area of climate education has been slow in coming to medical schools, the pace is picking up as all health professions are forced to grapple with the increasingly direct implications of climate change. The COVID-19 pandemic is one example of a global health crisis with direct links to ecosystem degradation, exacerbated by global warming, and highlighting the extreme urgency of accelerating the pace of change. An increase in the recent literature on this topic as well as coordinated national and international initiatives by well-organized student groups is an encouraging sign that the importance of integrating climate change into medical school curricula is being recognized, with institutions highlighted in this report leading the way on change.

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