



Short communication

Necessity and implementation of climate and health education for medical students and physicians

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As the climate crisis intensifies, it is necessary for medical students to be trained to recognize, address, and mitigate the resulting health harms on individual patients and their communities via climate and health education (CHE). The World Health Organization and Lancet declared that climate change is the greatest threat to human health in the 21st century [1]. Several professional societies, including the American Medical Association, have released statements in support of CHE for pre-clinical, clinical, and continuing medical education [2]. To advocate for CHE, medical students in the United States (U.S.) have recently formed a national alliance: Medical Students for a Sustainable Future (<https://ms4sf.org/>). Despite these calls for action, current medical education in the U.S. and globally does not sufficiently include climate and health topics [3]. Since medical education aims to teach learners how to diagnose, treat, and prevent diseases as well as promote public health, the effects of climate change on human health and health systems are appropriate and essential content.

CHE for medical students must encompass a multidimensional presentation of the broad health effects of climate change, ranging from the individual to systems level. Components of climate change include heat waves, rising sea levels, and extreme weather events. They can have significant effects on the human body that are organ-specific or systemic. For example, wildfire-associated air

pollution is associated with negative respiratory, cardiovascular, neurologic, dermatologic, and reproductive health effects. Alterations in weather patterns can disrupt food systems and vector distributions, contributing to increased risk for malnutrition, poor mental health, and vector-borne diseases [4]. CHE must also frame these effects from a social perspective in order to highlight climate injustice. Low-income and racial minority communities experience disproportionately increased climate-related health burdens [4], which may be evident in the local patient population that medical students serve. In addition, CHE should include information on how climate change affects care delivery systems and vice versa. For instance, power grid interruptions during a hurricane can cause far-reaching disruptions to care, which is why learners must be educated on disaster preparedness protocols and how to adapt clinical care accordingly. They should also recognize the contributory role of healthcare systems in the climate crisis, which are responsible for significant energy use and waste production [5]. This knowledge prepares students to promote climate resilience within healthcare delivery infrastructures. Lastly, CHE should discuss advocacy for mitigating upstream causative factors of climate change. Students should learn that bolstering climate solutions, such as policies that ban fracking and divestments from the fossil fuel industry, can simultaneously produce human health co-benefits [6]. Advocacy education provides learners with the capacity to become change agents in the realm of planetary health.

A significant impact of CHE for medical students, residents, and practicing physicians is improved patient care [7]. Priming students

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to recognize climate-induced effects on the health of individual patients and communities will improve their clinical reasoning and patient counseling skills. For example, CHE will allow them to identify air pollution as a potential cause for patients' asthma, heart failure, or atopic dermatitis exacerbation and to educate patients about staying cool during heat waves to reduce risk for heat stroke. Physicians are already taught how to counsel patients on effective lifestyle changes for improving wellbeing, such as reducing smoking and increasing physical activity. It should also be their duty to educate patients about prevention strategies to reduce their risks for adverse health outcomes associated with climate change, especially for those belonging to susceptible populations like children and the elderly.

Even though CHE is relevant for medical students and has benefits for clinical practice, it has been barely integrated into pre-clinical and clinical education [1]. Some medical schools in the U.S. offer a few lectures, online modules, or an elective course on climate and health topics for pre-clinical students [4]. However, many of these educational programs are offered for a short period of time and are optional for students. This is an insufficient approach to teach students about the complexities, inequities, and relevance of climate change and human health. CHE must be integrated longitudinally throughout the medical curriculum, and it can be infused across traditional medical disciplines, including pathology, pharmacology, microbiology, and clinical skills [8]. Examples include the roles of inflammation in the air pollution-induced pathogenesis of cardiovascular diseases, heat-related adverse effects of anticholinergic medications, and changes in the spread of West Nile virus. During the clinical curriculum, learners should develop skills in taking an environmental/climate health history and educating, diagnosing, and managing patients who experience physical and mental health effects of climate change.

There are many strategies for implementing CHE throughout the medical curriculum. CHE must be introduced near the beginning of medical school in order to build the professional identity of the "eco-ethical" physician who recognizes the responsibility of caring for patients whose health is impacted by climate change [9]. Infusing the breadth of climate-related health effects into pathophysiology lectures during the pre-clinical curriculum can be achieved within the appropriate sections of an organ-based block curriculum. These didactic lectures are helpful for conveying key climate and health information, but they should be supplemented with active learning modalities [8]. These include, but are not limited to, engaging small group discussions, online modules and videos with reflections, case vignettes, journal club articles and reflections, debates, and standardized patient encounters. An example of a team-based, inquiry-driven pedagogy for CHE is problem-based learning, in which students would work through cases together to analyze climate-driven causes of poor health. Also, schools can train medical students on a collaborative approach to climate-informed health care through combining CHE content and interprofessional education. For example, a standardized patient encounter involving management of an elderly migrant farmworker presenting with acute diarrhea, cough, and anxiety whose town experienced flooding during a hurricane would draw on the expertise of medical, pharmacy, nursing, and social work students.

CHE is also needed beyond medical school. Medical education on climate and health topics for residents can be achieved using didactics, online modules, debates, small group discussions, and community-based advocacy projects [6]. CHE integration in clinical education can include providing residents with opportunities to treat and screen for climate-associated physical and mental health effects. They should also gain experience counseling patients on how to prevent air and water pollution exposure. Learning objectives for residents should include effective clinical manage-

ment and patient education of climate-related health effects as well as awareness of disaster preparedness practices [6], which is especially relevant given the COVID-19 pandemic. Examples of CHE assessment and participation include direct observation and feedback, objective structured clinical examination (OSCE), organization of disaster drills, and quality improvement and advocacy projects.

Practicing physicians and academic faculty who work with medical students and residents have significant roles in promoting CHE. The medical education team at each school should provide faculty with assistance in developing their curriculum and aim to sustain faculty engagement. To prepare faculty members to teach on this topic, faculty development, grand rounds presentations, and continuing medical education need to be implemented. Some of these strategies are also effective for training practicing physicians how to counsel patients on climate and health topics, as this is likely a skill they did not learn during medical school and residency. The importance of continuing medical education cannot be overstated; physicians must stay abreast of advancements in climate and health knowledge. In addition, they must remain cognizant of their contributions to climate change on a personal level as well as a professional level, with the healthcare sector contributing to 10% of U.S. carbon emissions [5]. Physicians can use their medical expertise and positionality within society to advocate for sustainable healthcare practices within their clinical environment as well as large-scale community and policy initiatives. In doing so, they address their responsibility to advocate for their patients' health inside and outside the clinical setting in regards to climate change, as a healthier planet leads to healthier patients.

It is time to broadly institutionalize CHE throughout medical education globally. To do so, nationally mandated core milestones that incorporate CHE competencies for each stage of medical education (similar to the United Kingdom General Medical Council's Outcomes for Graduates [10]) are needed around the world. Some medical schools in Germany, the United Kingdom, Canada, and Australia have already begun to test curricular interventions related to CHE. To support widespread CHE implementation, assessment methods in medical school and residency as well as examinations for medical licensure, license renewal, and specialty certification should be updated to reflect objectives specific to climate and health knowledge. They should include questions about the effects of climate change on human health, as this knowledge is integral to providing high-quality patient care and will incentivize medical programs to implement CHE.

Medical curriculum reform that comprehensively integrates CHE is vital. CHE will develop a generation of medical providers who have a multidimensional awareness of the climate crisis and its resulting health, social, and economic consequences. They will be equipped with the knowledge and skills to manage climate-induced symptoms to improve the health of their patients as well as craft climate solutions to improve the health of the planet.

Ethical approval

Not applicable for this article.

Declaration of Competing Interest

The authors report no conflicts of interest and no funding sources for this work.

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