Review Article

Educating tomorrow's doctors on climate change, artificial intelligence and providing care to an aging population

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Abstract

Medical students should be educated to face tomorrow's health challenges. In this review, we discuss how students can be educated to address three major challenges. The main areas of this article were identified through discussion and consensus among the authors. The databases, 'PubMed' and 'Google Scholar', were searched using appropriate keywords. The articles were carefully reviewed by the authors for inclusion.

Climate change is a major challenge with serious implications for global health. The topic should be embedded across multiple curricular areas, and environmental determinants of health should be incorporated in all activities. Artificial intelligence (AI) is being increasingly used in medicine, offering major benefits but also presenting significant challenges. Medical students should be AI literate. They should be able to critically evaluate AI applications. They should have the competency to convey diagnostic information and probabilities provided by AI applications to patients. The population is rapidly aging, and chronic conditions are becoming common. Physicians should develop geriatric competencies and a patient-centred approach. By educating students on these important areas, physicians will be better equipped to foster an improved health care system and a healthier population. Medical students should be educated in these three areas of climate change, artificial intelligence and providing healthcare to an aging population.

1. Introduction

The world faces several pressing problems with significant health impacts ranging from climate change, increasing human population, ageing of the population, changes in our political structure and freedoms among others. The healthcare workforce is changing, and physicians of tomorrow will increasingly be working in multidisciplinary teams, supported by technology, and dealing with an aging population with complex diseases, and deal with more aware patients and an increased need for patient autonomy.[1] Future doctors should be able to think creatively and out-of-the-box and effectively demonstrate 'people skills' like empathy, teamwork, communication skills and demonstrate a knowledge of the social determinants of health. In this article we examine three major health challenges and strategies to educate medical students to address the same.

2. Methods

The topics were identified through discussion and consensus among the authors, and a review of literature was conducted to identify important studies in these areas. The databases PubMed and Google Scholar were searched using the search terms 'medical students', 'curriculum' and 'climate change'. A similar search was carried out using the words 'Artificial intelligence', 'curriculum' and 'medical students. Other search terms used with 'medical students', 'education' and 'curriculum' were 'aging population', 'geriatrics', and 'chronic diseases'. Articles published during the period from 2015 to 2024 were preferred for inclusion. Articles published earlier were however, not excluded. The search was carried out by the first author. The authors carefully went through the studies identified and selected those most relevant to the study objectives and relevant to a developing nation setting.

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Table 1: Factors related to the challenges of climate change, artificial intelligence and aging population

Challenge	Related factors
Climate change and global health	1. Disruption of indigenous knowledge systems 2. Air pollution, pesticide and chemicals, plastics, warming of oceans 3. Introduce and strengthen sustainability in healthcare 4. Interdisciplinary education and collaboration 5. Challenges to food security 6. Changing patterns of diseases 7. Sea level rise 8. Psychological impact
Artificial intelligence and medical technology	1. Importance of healthcare providers in validating AI systems 2. Can reduce information overload and support professional development 3. Ethical concerns due to possible biases in training data, data privacy and lack of transparency in operation 4. Core areas for medical students 5. Involvement of healthcare providers with AI systems
Aging population and chronic disease management	1. Increasing elderly population and higher risk of chronic diseases 2. Growing importance of primary care physicians 3. Shortage of geriatricians 4. Emphasize patient-centeredness, empathy, holistic approaches, and teamwork 5. Advanced monitoring technologies and preventive care 6. Provision of continuous personalized care

Table 2: Educational initiatives to address the challenges related to climate change, artificial intelligence and aging population and chronic diseases

Challenge	Educational initiatives
Climate change	1. Highlight the importance and relevance of traditional knowledge systems 2. Involve medical students in educational and other initiatives 3. Incorporate sustainability practices in hospitals and clinics 4. Embed climate change and sustainability in curricula 5. Offer climate health specialization tracks 6. Develop interdisciplinary research programs
Artificial intelligence	1. Collaboration with computer scientists 2. Strengthening knowledge of mathematics and data science 3. Incorporate AI throughout the curriculum 4. Develop students' ability to critically evaluate AI-generated data 5. Incorporate questions on AI, data science and electronic health records in licensing exams 6. Educate students to make ethical decisions regarding AI applications
Aging population and chronic disease management	1. Establishing relationships with older individuals, engaging in their lives, and serving as role models 2. Incorporate geriatric competencies, psychiatry and assessment in the curriculum 3. Interprofessional education, senior mentors, simulations, reflective journals 4. Longitudinal patient care tracking

The abstract of the article was reviewed by the first author, and the other authors provided their input on whether the selected article abstract met the aims of the study. The full text was then obtained and shared with all the authors by the first author to obtain their input. The authors communicated online and met if required. Our review of literature may not however, be comprehensive nor detailed. Many educational institutions in developed economies have introduced these topics in the curriculum. In developing nations these topics should be introduced quickly to ensure students who graduate are future-ready.

3. Climate Change and Global Health

The concept of 'one health' aims to acknowledge the close interconnection between and sustainably balance and enhance the health of humans, animals, and ecosystems.[2] Traditional indigenous knowledge systems (defined by UNESCO as 'Knowledge, innovations and practices of indigenous and local communities around the world. These have been developed from experience gained over the centuries and adapted to the local culture and environment, traditional knowledge is transmitted orally from generation to generation[3] were founded on the principles of relationality and reciprocity between humans and non-human entities within the earth's ecosystems, but these have been disrupted largely due to a global economy driven by resource extraction and the consumer habits of the affluent.[4] This has exacerbated the climate change crisis.

Climate change (CC) is projected to result in at least 250000 additional fatalities each year between 2030, and 2050.[5] Future physicians should understand how air pollution contributes to lung diseases, the impact of pesticides on fertility, and how the loss of biodiversity and deforestation can lead to the emergence of new diseases and vectors.[6]

Particularly in the United States (US), medical students have emerged as transformative agents in determining what CC knowledge future doctors should possess and its health implications.[7] While curricula have been introduced information about how many schools offer these curricula and their possible educational impact is lacking. US medical schools have launched various initiatives aimed at embedding CC and sustainability into their curricula. However, a recent qualitative study identified several obstacles in integrating planetary health topics into the undergraduate medical curriculum.[8] These include an insufficient curricular time, low awareness among both students and educators, and possibly a lack of knowledge among educators as well as senior management.

Embedding CC education across multiple curricular areas and subjects has been emphasized by HP educators. Twelve recommendations for teaching environmental sustainability to health professionals include underlining the significance and urgency of addressing planetary health, linking these subjects to broader educational and professional goals, preparing students for the health consequences of CC,

motivating learners by showcasing the health advantages of mitigation efforts, incorporating environmental determinants of health in all educational activities, learning environmental sustainability in the foundational curriculum, and evaluating students through formative, portfolio-based, and student-led activities that will foster reflection.[9] There are three primary motivations for incorporating CC into the curriculum.[10] These include preparing students for their future practices, enhancing literacy in public and eco-health, and enriching existing learning while strengthening the qualities of graduates. **Table 1** summarizes factors related to the challenges related to climate change, artificial intelligence and an aging population and chronic disease management while **Table 2** highlights the different educational initiatives to address these challenges.

Artificial intelligence (AI) is increasingly being used in healthcare and in health professions education (HPE) and has the potential to address many of the challenges posed by CC.

4. Developing artificial intelligence (AI) literacy

Artificial intelligence (AI) serves various functions in healthcare and the training of future medical professionals. Healthcare providers (HCPs) will be crucial in validating AI systems by supplying data and testing them in real-world scenarios.[11] AI can aid student learning by offering personalized feedback and developing customized learning pathways. This technology has the potential to alleviate information overload and assist in ongoing professional development. However, AI can also present several ethical concerns, such as a lack of transparency in the operational processes, biases in the training data, and issues regarding safety and data privacy.[12]

Only a limited number of students have received training in this area.[13] Students have expressed interest in understanding clinical applications, programming, algorithm development, and evaluation of algorithms. A multidisciplinary approach that includes collaboration with computer science students has been suggested. Future clinicians will frequently rely on AI-driven predictions to make decisions.[14] It is essential for students to understand the diverse AI tools available, the frameworks for utilizing AI solutions for clinical challenges, and the importance of data in creating AI tools. AI technologies can enhance data collection regarding diseases, as well as patient beliefs, values, and preferences, thereby diminishing uncertainty.[15]

Gaining a solid understanding of data science may necessitate a strong grasp of mathematics, and medical school entrance exams may assess candidates' knowledge of mathematical concepts.[16] A sustained approach to integrating AI into the medical curriculum is advisable. In the preclinical phase, emphasis can be on data curation, data quality, managing electronic health records, ethical and legal considerations, and critical evaluation of AI technologies. During clinical training and residency, the focus should shift to the practical applications of AI in a medical setting. Students

interested in developing innovative technology-driven care models could be offered specialized training opportunities. Medical students must cultivate a strong comprehension of the four Vs of big data: volume, variety, velocity, and veracity. Volume refers to the large amount of generated and stored data while variety refers to the multi-type and multi-source of data.[17] Velocity refers to the high speed at which data is generated and processed, and veracity is the high quality and value of the captured and processed data.

Students should be aware of the ethical challenges of AI, know about the theory behind and the common applications of AI, be able to communicate with patients, other healthcare professionals and professionals from other disciplines about AI. Case-based learning and simulations can facilitate the integration of AI into clinical practice. Institutions might provide access to online courses developed by other organizations. Licensing exams could incorporate questions regarding data science, AI, and electronic health records. Physicians who do not use AI could get substituted by those who utilize AI and technologies in their routine daily practice.[18] AI may handle the more routine tasks in medical care leaving physicians freer to handle tasks requiring creativity and out of the box thinking. **Table 1** and **Table 2** summarize factors related to the challenge and the different educational initiatives. AI has the potential to address many of the challenges posed by the rapidly aging population and the increase in the prevalence of chronic diseases.

5. Aging Population and Chronic Disease Management

The worldwide elderly population will rise to 1.4 billion by 2030 and reach 2.1 billion by 2050.[19] Approximately 25% of the total global burden of mortality and morbidity impacts individuals aged 60 and older; linked to chronic illnesses from conditions such as cancer, chronic respiratory diseases, heart disease, musculoskeletal disorders, as well as mental and neurological ailments. Primary care physicians will be crucial in delivering care to elderly patients with chronic illnesses and should be trained in geriatrics principles.[20] Geriatricians can acquire educational and leadership capabilities, allowing them to teach their peers about geriatric care. Essential elements of a physician's professional identity in relation to the elderly include patient-centeredness, empathy, holistic approaches, and teamwork.[21] Establishing relationships with older individuals, engaging in their lives, and serving as role models are significant factors. Medical students might have unfavourable views of the elderly, but fostering a suitable professional identity can help mitigate these negative perceptions.[22]

A recent scoping review highlights the need to incorporate minimum geriatrics competencies, geriatric psychiatry, and comprehensive geriatric assessments.[23] Geriatric medicine can be vertically integrated into medical curricula using interprofessional education, senior mentorship, simulations, reflective journals, clinical placements, and e-Learning.[24] Communication skills, empathy, and professionalism should

be emphasized. Key topics include delirium, pharmacotherapy for the elderly, healthy aging and promotion, frailty, elder abuse, and telemedicine.

In the UK, simulation methods addressed topics that are seldom taught formally, such as assessment of continence, end-of-life choices, and multidisciplinary teamwork.[25] A simulation session focused on delirium, falls, elder abuse, and difficult conversations was created, incorporating simulation mannequins, professional actors, and simulated clinical records.[25] There was a notable improvement in student knowledge, which was retained one month following the session.

6. Implementing Educational Initiatives and Reforms Related to Climate Change in Resource Limited Settings

Educational reforms to integrate climate change education into undergraduate medical curricula in resource-limited South Asian settings can be achieved through various practical and cost-effective strategies. Embedding climate-health content within existing courses—such as physiology, community medicine, and emergency medicine—minimizes the need for extensive curricular restructuring and additional resources. For example, focused teaching on heat-related illnesses can be incorporated into physiology and emergency medicine blocks, requiring minimal effort but delivering significant impact in preparing students for climate-driven health emergencies.[26]

Community-based learning and participatory approaches are particularly effective in South Asia, where medical schools often serve diverse and vulnerable populations. Engaging students in local health campaigns, environmental health projects, and advocacy for climate adaptation not only contextualizes learning but also leverages existing community resources. Medical students, as trusted community voices, can play a vital role in promoting public awareness and influencing policy, especially when trained in advocacy and networking skills.[27]

Digital and mobile technologies offer scalable solutions for climate change education in settings with limited infrastructure. Low-cost online modules, mobile learning platforms, and open-access resources can supplement traditional teaching, making climate-health education accessible even in rural or under-resourced institutions. International organizations and professional bodies can support these efforts by providing free or subsidized teaching materials and faculty development programs.[28]

Faculty development is essential for sustainable reform. Peer-led workshops, online seminars, and integration of climate-health topics into existing professional development activities can build faculty capacity without significant financial investment. Autonomy for individual institutions to contextualize curricula ensures that reforms are relevant and feasible within local constraints.[26]

Despite these opportunities, significant gaps remain in the formal inclusion of climate change in medical curricula across South Asia. Surveys indicate that most medical schools in the region lack structured teaching on climate-health links, underscoring the urgent need for policy support and institutional commitment to reform.[29]

7. Limitation of the Study

The study was carried out only using two databases. The review of literature is not exhaustive, and studies may have been excluded. Our objective was not to provide an exhaustive overview of the topic. The studies included were selected through consensus among the authors and personal bias could have influenced the selection.

8. Recommendations for Future Research

The literature from developing nations and South Asia on this topic is limited. Additional investigation must focus on key deficiencies in training physicians for planetary health, machine learning technologies, and elderly patient care. Research must explore best practices for curriculum incorporation, instructor training requirements, and uniform skill assessment standards. Exploring connections among these topics—like applying machine learning to manage climate-induced health problems in older adults—offers important opportunities. Comprehensive literature analyses and partnerships across multiple institutions are vital for developing strong evidence supporting tomorrow's healthcare workforce preparation.

9. Summary of Recommendations

1. Climate change education should be embedded in the curriculum and integrated across multiple areas. Students should be able to implement sustainability in healthcare and advocate for policies to reduce the impact of climate change.
2. They should be knowledgeable about data curation, data quality and electronic health records, the ethical and legal consideration of AI technologies and be able to critically evaluate these technologies. These should be incorporated in the curriculum and the expertise of computer scientists and data scientists can be utilized.
3. Primary care physicians should be able to provide care to the increasing elderly population. Geriatric competencies, communication skills, healthy aging and telemedicine should be addressed. Various methods including simulation can be used.

10. Conclusion

By concentrating on these key areas, health care professionals will be better equipped to foster an improved health care system and a healthier population. Health professions educators should cultivate healthcare providers who are genuinely collaborative, community-focused, knowledgeable about social determinants of health, and resilient.

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