Introduction

There are few aspects of human health that will remain unchanged as the earth warms in the next decades. It is projected that by 2030 over 250,000 deaths will be attributed to climate change each year.[1] The nature of this mortality is multifactorial and impacts every system of the human body. It is projected that heat related mortality, diarrheal illness, vector borne illness, and malnutrition will be the primary drivers of climate related deaths.[2] Using heat related mortality as a case study, a 2003 heat wave in France killed 15,000 people.[3] This morbidity and mortality are only projected to increase. In fact, weeks ago, France underwent a heatwave that was both longer and more severe than the one experienced in 2003.[4] Its effects have not yet been quantified. Though the effects of climate change will be more drastic in other areas of the world, these threats are no longer distant. At the time this application is written, the heat index in Ann Arbor is 103 degrees. Last night, a severe thunderstorm blew through southeastern Michigan leaving 217,000 without power, and thus without respite from the heat.[5] Additionally, five out of the last seven days have seen ozone levels so high that it has been recommended that individuals— particularly those with respiratory conditions— limit their time outside. The effects of a warmer planet are no longer a problem for a future generation of physicians.

The medical profession is beginning to react to these changes and projections. In fact, the effects of climate change on health are so enormous that 74 health care associations recently released a call to action.[6] In this call to action, these organizations go so far as to call the effects of climate change on health a public health emergency.

Not only will climate change affect the health of all of our patients, but the United States healthcare system is a large contributor to carbon emissions. It is estimated that in 2007, the US healthcare system released 504 million metric tons of carbon dioxide equivalents,[7] or roughly 7% of total US emissions.

Yet, despite all of this, the current medical school curriculum makes no mention of the role climate change will play in human health during the clinical practice of current medical students. As medical students, we are taught to appreciate the whole patient when they walk into the clinic. Socioeconomic factors and social determinants of health have long occupied more time in most of our clinics than the physiology of lipid metabolism, but, as a field, we are yet to incorporate the effects of climate change on health into formal medical education and clinical practice.

This application aims to develop a multidisciplinary educational elective for Branch medical students. This elective will aim to prepare students who enroll to better serve their patients and become leaders in both health systems and society as the United States healthcare system responds and adapts to a warmer world. Upon completing this course, it is our hope that students will be well positioned to become physician leaders in the truest sense of the word. They will be prepared to be advocates for patients affected by climate change at a local, national, and global level.

Specific Aim 1: Create a curriculum that educates medical students on the health impacts of climate change and prepare them to address these issues in a clinical setting. **Specific Aim 2:** Engage medical students in examination of the health care industry's role in climate change, carbon emissions, and physical waste generation and encourage problem creative problem solving, better preparing medical students to become future leaders.

Project Design

The curriculum at UMMS has seen drastic changes over the last several years, which have culminated in increased opportunities for medical students to explore their interests and bridge the "impact gap" historically noted with traditional medical school curricula [8]. This sets up the ideal venue for addressing the dearth of education around climate change as it relates to both individual and planetary health.

To achieve our Specific Aims, we propose a non-clinical elective on climate change, health, and health care sustainability. Given the enormity of the climate change crisis and the fact that it will become the biggest public health issue facing the next generation of medical professionals, we are proposing a multi-disciplinary approach that is **innovative in both the content it covers as well as its project based learning**.

Aim 1 will be completed by developing a curriculum for this elective that enables the learner to better understand the challenges healthcare faces in the setting of climate change. This curriculum will blend physiology, medicine, sociology, and political science to offer in-depth education on the relationship between climate change and health as well as the societal context it takes place in (Table 1). It will also incorporate experiential learning, including panel presentations and trips, to give students a deeper understanding of the problem and its multifaceted solutions.

Table 1: Proposed Curricular Topics

Physics of climate change
National discourse of climate change
Health effects of climate change
Heat morbidity
Particulate air disease and ozone pollution
Disaster response
Malnutrition
Vector borne illness
Sustainable health practices
Personal sustainable practices
Policy solutions at a local, national, and global scale

Aim 2 will be completed using project-based learning. Students will be expected to select a topic related to climate change and health or sustainable health care practices during the elective for their final project. The final project will consist of a literature review, development of an actionable proposal, and presentation to fellow students. In order to help students develop problem solving and leadership skills, students will be encouraged to develop these projects into Capstones for Impact, connect with environmental non-profits, discuss with hospital leadership, and contact policy makers at a local, state, or federal level. Additionally, students will be expected to design an experiential learning opportunity during the course. Possibilities include trips to Lansing to engage with policy makers, experiences with the Public Health Department in Detroit related to air pollution, trips to local schools to provide education on the health impacts of climate change, and trips to local farmers to learn about the impact of climate change on agriculture and nutrition.

This elective is ambitious in its attempt to incorporate many fields of knowledge into one course. This challenge will be addressed through collaboration with graduate and professional schools

across the University of Michigan's campus. We will develop this curriculum with the input of faculty and graduate students at the Ford School of Public Policy, School for Environment and Sustainability, School of Public Health, Institute for Health Care Policy and Innovation and more. This initial Mini-Grant would support the development of a branch elective for medical students. However, there are opportunities to develop a climate change and health curriculum longitudinally through the medical school experience. Following development and piloting of the proposed elective, efforts would be made to develop similar curricula for the Scientific and Clinical Trunk, Doctoring Sessions, Leadership, and Paths of Excellence.

Outcomes Assessment

To assess the outcome of our curriculum, we propose the use of 3 metrics. First, we will conduct a comprehensive needs assessment by surveying current Branch students about their knowledge of climate change and health. This metric will allow us to tailor our curriculum to the needs of the student body. Second, every student enrolled in the elective will be given a pre-test that captures their knowledge of climate change, health, and sustainable medicine. At the end of the elective, students will complete a post test focused on assessment of knowledge learned during the course, feedback on the course, and their likelihood of incorporating their new knowledge into their career. For the first 6 cohorts of students enrolled, we will also conduct exit interviews to capture qualitative data about the course to improve upon it in future iterations.

Recruitment

Though spearheaded by Emily Johnson, this grant was developed and supported by the leadership of a medical student co-curricular group "White Coats for Planetary Health (WCPH)." This is a group formed to educate medical students about climate change and health, advocate for more sustainable practices within Michigan Medicine, and connect medical students with resources and nonprofits in the climate change and sustainability area.

Core RISE MiniGrant Team: Emily Johnson (Branches), Jonathon McBride (MSTP), Anita Vasudevan (Branches), Hanna Saltzman (Branches)
WCPH Collaborators: Alex Kolenda (Scientific Trunk), Casey Patnode (Clinical Trunk), Laura Donahue (Branches)

In addition to students, the curricular team of the medical school will be approached to assist in the development of this elective. Outside of Michigan Medical school, we plan to collaborate with Ford School of Public Policy, School for Environment and Sustainability, School of Public Health, Institute for Health Care Policy and Innovation.

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