

**EMERGENCY REGISTRARS' AND PHYSICIANS' PERCEPTIONS AND PREPAREDNESS TO RESPOND TO THE
HEALTH IMPACTS OF CLIMATE CHANGE: A SURVEY STUDY**

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Summary

Climate change has many significant impacts on health. These impacts occur on top of existing conditions, which places a disproportionate burden on those who are already vulnerable. Emergency healthcare, which is responsible for all acute and urgent aspects of illness and injury, often serves as the first point of contact in the health system for patients who have been affected by climate change. However, it is expected that many emergency medicine specialists are not well versed on the health impacts of climate change, making it essential to assess their current perception of and preparedness to address these impacts in clinical practice.

To create an understanding of emergency medicine registrars' and physicians' perceptions about climate change and health, climate-related health education, and self-perceived preparedness to respond to these impacts, this study followed a survey design, using an online questionnaire to collect data. Data were collected from emergency medicine registrars' and physicians' who are currently working in South Africa. The data were first analysed descriptively, and Mann-Whitney U tests were conducted to explore differences amongst sub-groups.

Results indicated that most (80%, $n = 16$) participants recognised the health impacts of climate change and felt that it would impact their own and their patients' health. None of the participants however received any formal training on the topic and only 3 (15%) participants indicated that they probably have enough information to prepare for the health impacts of climate change. Exploratory analysis indicated that the extent to which participants agreed with the statement that climate change will affect their personal health scores was statistically significantly higher for those who identified as women than for participants who identified as men ($p = .024$).

There is a need for better integration of climate-related health education into medical curricula to prepare emergency medicine specialists in response to the health impacts of climate change.

Key Terms: emergency medicine, emergency healthcare professional, climate-related health impacts, climate-related health education, medical curriculum, emergency healthcare preparedness, gender differences.

Chapter 1: Introduction

According to the Pan American Health Organisation (PAHO), climate change is the “biggest global health threat of the 21st century”.⁽¹⁾ Climate change has several direct and indirect consequences for health⁽¹⁻⁵⁾ with a disproportionate impact on vulnerable populations.⁽⁶⁾ Healthcare also contributes to climate change as large quantities of carbon emissions are produced during the healthcare process.^(7,8) Emergency healthcare, with its focus on those who are acutely ill or injured, is often the first point of contact for patients who have been affected by climate change. It is therefore essential that emergency medicine specialists are appropriately informed and prepared to effectively address climate change and health in practice. However, very little to no information exists about emergency medicine specialists’ understanding and preparedness related to climate change and health.

According to several studies, healthcare professionals (HCPs) recognise the link between climate change and health,⁽⁹⁻¹¹⁾ but they believe they lack the training and education to sufficiently prepare them to appropriately respond to the health impacts of climate change.⁽¹²⁻¹⁴⁾ These studies do not explicitly involve emergency medicine specialists nor is it clear whether this group is represented in these studies. Research however has shown that the integration of climate change into medical curricula is largely lacking^(12,15,16) alluding to the possibility that emergency medicine specialists, much like other HCPs, may not be receiving formal training to help them prepare and respond to climate-related health impacts, and as a result, may be insufficiently prepared to do so. It is then not surprising that, globally, there is a strong call from medical students and educators⁽¹⁷⁻²¹⁾ as well as emergency medicine specialists⁽²²⁾ for the inclusion of climate-related health education in medical curricula.

The inclusion of climate-related health education in medical curricula could increase emergency medicine specialists’ understanding of the relationship between climate change and health and how to prepare for it in clinical practice. An increased understanding of the topic could also inspire greater involvement in the implementation of climate change mitigative and adaptive plans in the healthcare system⁽²³⁾ and stimulate a group of trusted and instrumental voices in the community to advocate for climate change.⁽²⁴⁾

Very few studies on the African continent have explored emergency healthcare preparedness as it relates to the health impacts of climate change.⁽²⁵⁾ Also, not much is known about emergency medicine specialists’ understanding, perceptions, training and education needs, and level of preparedness as it relates to climate change and health. It is expected that many emergency medicine specialists are not well versed on the health impacts of climate change, and it is therefore imperative to assess and address the knowledge gap that likely exists.

To create an understanding of this group of HCPs’ perceptions about the topic, this study describes emergency medicine registrars’ and physicians’ perceptions of climate change and health and climate-related health education and their perceived preparedness to respond to the health impacts of climate

change. It is expected that this information could inform some of the first steps towards integrating climate change and health in medical school curricula and workplace training in South Africa, which could increase emergency medicine specialists' preparedness to address climate change and health in their clinical practice and the community. It should be noted that while the study focussed on postgraduate students and graduates, the question remains about where in the medical curricula to introduce climate-related health education.

This study aimed to describe emergency medicine registrars' and physicians' perceptions of climate change and health, climate-related health education, and self-perceived preparedness to respond to these impacts.

Following this, are the research objectives:

Objective 1: To describe perceptions of emergency medicine registrars and physicians related to the health impacts of climate change.

Objective 2: To describe self-perceived preparedness to respond to the health impacts of climate change.

Objective 3: To describe perceptions, level of engagement, and expectations related to climate change in medical education and training.

Objective 4: To describe the perceived priorities to focus on that are expected to increase preparedness to respond to the health impacts of climate change.

The dissertation consists of six chapters:

- Chapter 1 (This chapter)
- Chapter 2 provides background information that places the research problem within the broader context from which it is derived.
- Chapter 3 provides an overview of the relevant literature and explains the necessity for further research on the topic.
- Chapter 4 introduces the research aim and objectives and discusses the research methods that were followed in the study.
- Chapter 5 provides the research results.
- Chapter 6 discusses the results and limitations of the study, opportunities for future research, and the contribution of the study.

Chapter 2: Background

To contextualise the study, this chapter provides an understanding of the health impacts of climate change and how this relates to emergency healthcare. It also situates the research problem within the nexus between climate change, health, and vulnerability.

Climate change, health, and emergency healthcare

Climate change has a detrimental impact on human health. ⁽²⁶⁾ Climate change refers to a long-term change in the Earth's average temperature and weather patterns. Whilst these shifts may be natural, certain human activities are causing these changes to accelerate, resulting in human-induced climate change. Human-induced climate change has led to changes in natural systems, such as changes in precipitation patterns, acidification of oceans, melting of glaciers, and changes in the behaviour and ecology of species and ecosystems. ^(1,27,28) In turn, these changes are causing sea levels to rise, changes in the distribution of vector-borne diseases and pathogens, and an increase in the frequency and intensity of extreme weather events, such as floods, droughts, and heatwaves. ⁽¹⁾

According to the Pan American Health Organisation (PAHO), climate change is the "biggest global health threat of the 21st century". ⁽¹⁾ Climate change has several direct and indirect consequences for health ⁽¹⁻⁵⁾ and has been associated with changes in patterns of injury, disease, and death. ⁽²⁹⁾ The direct impacts on health are often caused by extreme weather events, such as floods, droughts, and heatwaves, and can cause injuries, death, and other health outcomes, such as cardiovascular disease (CVD). ^(1,30) Health is also indirectly impacted by climate change as a result of the "environmental, ecological, and social impacts of a changing climate". ^(27, p.403) These indirect impacts on health include gastroenteritis caused by water pollution after heavy rains or flooding, an increase in vector-borne diseases due to more favourable conditions for the survival of pathogens or vectors (such as malaria and Lyme disease), an increase in CVD due to water scarcity and food insecurity, displacement and conflict over diminishing resources, and delayed health impacts of extreme weather events (such as mental health disorders). ^(1,29,30)

Emergency healthcare, which is responsible for all acute and urgent aspects of illness and injury, is often placed at the forefront of the response to these climate change-related health impacts. ⁽³¹⁾ Emergency departments (EDs) often serve as the first point of entry into the health system and, as a result, emergency medicine specialists are often the first point of contact for patients who have been affected by the impacts of climate change. ⁽³¹⁾ However, it should be noted that emergency healthcare in facilities, which includes primary healthcare, district, and tertiary level, is also provided by HCPs other than emergency medicine registrars and physicians.

Climate-sensitive diseases that have a high likelihood of presenting to EDs include heat-sensitive chronic conditions (such as respiratory and renal disease) due to heat waves, physical injuries caused by severe

weather events, and respiratory disease (such as asthma) caused by increased aeroallergen production.⁽³²⁾ Other conditions that are likely to increase in prevalence and present in EDs include gastroenteritis, urolithiasis, and vector-borne and zoonotic diseases.⁽³²⁾ As a result, it can be expected that EDs will experience an increase in the demand for its services on top of other expected increases attributable to, for example, population growth.⁽³³⁾ This is especially concerning in low-resource settings, such as South Africa, where timely and effective emergency healthcare is often limited by the availability of human and material resources.⁽³⁴⁾

It should also be noted that healthcare activities produce large quantities of carbon emissions, thus placing a high demand on the environment.⁽³⁵⁾ Therefore, besides addressing the health impacts of climate change, healthcare facilities and workers also have the responsibility to reduce carbon emissions produced by the healthcare system, thereby reducing the effect that climate change has on human health.^(7,8) It is important to mention that the current study did not investigate the participants' or the healthcare system's mitigative strategies to reduce the healthcare system's contribution to climate change.

The South African context

The current study is focussed on emergency healthcare in South Africa. South Africa has a growing population of approximately 62 million people of which 51.5% is female.⁽³⁶⁾

The burden of disease

The country has a high burden of disease, consisting of both communicable diseases (such as HIV/AIDS and Malaria) and non-communicable diseases (NCD, such as CVD).⁽³⁷⁾ The World Health Organisation reports that, in 2019, NCDs alone were responsible for 51% of reported deaths in South Africa.^(38,39) CVD, which accounts for most of the NCD deaths and disability worldwide,⁽⁴⁰⁾ is a leading cause of death in South Africa⁽³⁷⁾ and has increased dramatically over the last two decades.⁽⁴¹⁾ These health outcomes are expected to worsen with climate change,⁽⁴²⁾ thus increasing the burden of disease in South Africa.

Climatic variability

According to the authors of the IPCC Sixth Assessment WGII Report, the evidence to suggest that South Africa has already been impacted by human-induced climate change "is stronger than ever before".^(28, p.1) The report indicates that there has been an increase in extremely hot days, a reduction in rainfall over the winter rainfall regions, an increase in multi-year droughts, and an increase in the frequency and intensity of extreme rainfall events.⁽⁴³⁾ Three of the most recent examples of extreme weather events that occurred in South Africa and that are likely attributable to climate change are the 2016 to 2018 drought in Cape Town^(44,45), the 2022 floods in KwaZulu Natal (KZN),⁽⁴⁶⁾ and the 2023 floods in the Western Cape province.⁽⁴⁷⁾

These events have a devastating impact on health and health systems. This was highlighted in the aftermath of the KZN floods, in which hundreds of people lost their lives, tens of thousands of people lost

their homes, and infrastructure – including healthcare facilities – were extensively damaged. ⁽⁴⁸⁾ In a report reviewing the devastation caused by the KZN floods, the authors state that climate change has been largely ignored by health systems in both mitigation and adaptive strategies and that existing plans have underestimated the resources necessary to deliver health services during extreme weather events. ⁽⁴⁹⁾ They highlight that current disaster management plans have not taken into account the expected health impacts caused by climate change and recommend that these plans be updated to do so. ⁽⁴⁹⁾ Furthermore, they recommend better early warning systems and communication channels between stakeholders that ensure the timely activation of healthcare services to enable healthcare staff sufficient time for appropriate preparation to respond to the needs of communities during extreme weather events. ⁽⁴⁹⁾ These recommendations are in line with the United Nation’s 2030 Sustainable Development Goals (SDGs) 3 (Good health and wellbeing) and 11 (Sustainable cities and communities) that include targets and indicators for the strengthening of emergency healthcare and disaster response preparedness to reduce mortality and enhance resilience and adaptive capacity. ⁽⁵⁰⁾

Intersecting vulnerabilities

South Africa, which has recently been declared as the most unequal country in the world, ⁽⁵¹⁾ is characterised by poverty and inequality. More than 50% of the South African population live below the National Poverty Line (~ZAR 992) ⁽⁵²⁾ and close to 20% of households experience inadequate access to food ⁽⁵³⁾ – a statistic that worsened during the COVID-19 pandemic. ⁽⁵⁴⁾ The health impacts of climate change are expected to occur on top of existing vulnerabilities, ⁽⁴²⁾ exacerbating poverty ⁽⁵⁵⁾ and highlighting and increasing existing social inequalities. ⁽⁵⁶⁾

According to Chapter 9 of the WGII report on Impacts, Adaptation, and Vulnerability, the African continent - while being one of the lowest contributors to climate change - is extremely vulnerable to its impacts due to intersecting vulnerabilities in socioeconomic, political, and environmental factors. ⁽⁵⁷⁾ Certain groups of the population may also be especially vulnerable to the impacts of climate change, such as pregnant women, children, newborns, and the elderly. ⁽⁴²⁾ Islam & Winkel (2017) present a conceptual framework to explain the interaction between climate change and ‘within-country’ social inequalities whereby existing inequalities place vulnerable groups in an already disadvantaged position to the impacts of climate change. ⁽⁶⁾ As a result, these vulnerable groups experience increased exposure and susceptibility to the impacts of climate change and a lower ability to cope and recover from them. ⁽⁶⁾ This means that they suffer a disproportionate loss of income or assets after these impacts, worsening their position to the impacts of climate change and intensifying vulnerabilities. ⁽⁶⁾

The evidence suggests that this vicious cycle is visible in South Africa. In a systematic review of the literature that focussed on information related to the African context and published between 2014 and 2022, the authors found a complex interaction between climate change, poverty, and existing

vulnerabilities that intensified the burden of those who are already vulnerable. ⁽⁵⁸⁾ Khine & Langkullen, (2023) however note that most of the empirical data in the review were related to food and agriculture, and information about the health impacts of climate change was limited, thus indicating a need for research that explores the health, climate change, and vulnerability nexus in the South African context. ⁽⁵⁸⁾ This information could assist emergency medicine specialists in the climate-informed preparation of EDs that consider the intersecting vulnerabilities that exist in the communities they care for.

The healthcare professional's role

While there is recognition of the adverse impact that climate change will have on health, globally, ⁽²²⁾ very little to no information exists about the level of preparedness of emergency healthcare systems and professionals to respond to these health impacts.

In 2020, the PAHO released a pocket book that offers HCP information on how to identify and address climate-related health impacts in clinical practice, suggesting that there is a critical need for HCPs to be able to recognise and effectively treat the medical conditions attributable to climate change. ⁽²⁷⁾ The PAHO argues that it is the HCPs' role to adapt current procedures to enable them to respond more effectively to climate-related health impacts, identify the available information on early warning systems of climate-related events and disease outbreaks, identify vulnerable groups in the population, and provide appropriate risk reduction advice to patients and community members. ⁽²⁷⁾

Lemery et al. (2020) suggest that HCPs have three primary roles to support efforts that address climate risks. ⁽⁵⁹⁾ First, they have to protect individual and community health against the direct and indirect climate-related health impacts. ⁽⁵⁹⁾ Second, they should build healthcare and health systems that are resilient against the threats posed by climate change by focussing on both climate change mitigation and adaptation strategies. ⁽⁵⁹⁾ And third, they need to use their voices and scientific expertise to promote and support intersectoral solutions to the climate crisis. ⁽⁵⁹⁾

A gap in climate-related health education

To improve HCPs' understanding of the link between climate change and health, PAHO recommends that HCPs should receive training and education on the topic. ⁽²⁷⁾ This is in line with SDG 13 on climate action, which specifies the inclusion of climate change -related education in curricula and policy to support better education, awareness, and capacity of healthcare workers on climate change adaptation, mitigation, early warning, and impact reduction. ⁽⁵⁰⁾

An increase in the understanding of the health-impacts of climate change could result in greater involvement of HCPs in the implementation of climate change mitigative and adaptive strategies ⁽²³⁾ and stimulate a group of trusted and influential voices in the community to advocate for climate change. ⁽²⁴⁾ However, despite a call from medical students and educators to integrate climate change and health into

medical curricula^(18–21) research has shown that integration is largely lacking^(12,15,16) and several studies have indicated that HCPs believe that they lack the training and education to sufficiently prepare them to respond to the health impacts of climate change.^(12–14) It should be noted that despite the essential role that emergency healthcare has in the response to climate change, little to no information exists about emergency medicine specialists' understanding and perceptions of the topic.

In conclusion, climate change has many devastating impacts on health that are likely to increase the demand for emergency healthcare. These impacts place a disproportionate burden on those who are already vulnerable, which is especially concerning in low-resource settings, such as South Africa, that are already burdened by disease, inequality, and poverty. It is expected that many emergency medicine specialists are not adequately educated on the health impacts of climate change. It is therefore imperative to assess and address the knowledge gap of emergency medicine specialists regarding climate change and health.

An understanding of emergency medical registrars' and specialists' perceptions of climate change and health, climate-related health education, and self-perceived preparedness to respond to these impacts could help us to better understand their needs in terms of training, education, and preparedness. This information could guide educators in the initial steps to the integration of climate-related health education in medical curricula in South Africa. The inclusion of climate change and health education in medical education could produce a group of emergency medicine specialists who are prepared to protect individual and community health against the expected climate-related health impacts, build healthcare and health systems that are resilient against the threats posed by climate change, and use their voices and scientific expertise to endorse and support solutions to the climate crisis.

The next chapter discusses the existing literature as it relates to climate change and health in medical curricula and HCPs' perceptions of climate change and health.

Chapter 3: Literature review

This chapter aims to describe the most recent literature as it relates to the integration of climate-related health education in medical curricula and medical students' and HCPs' perceptions and expectations about the health impacts of climate change. The literature search was concluded in November 2023. A literature search was conducted by combining search terms for climate change, health, medical curricula, and emergency healthcare. The search was completed using Google Scholar and PubMed. Literature published in the last 5 years (2018 to 2023) was prioritised.

The current integration of climate-related health education into medical curricula

In a recent review of the literature, Brennan and Madden (2023) found that, over the last ten years, the question about climate-related health education changed from 'why' to 'how to' integrate it into the healthcare profession's curricula. ⁽⁶⁰⁾ However, while the topic seems to have gained momentum amongst medical students, educators, and researchers, information about its integration into medical curricula is sparse and the information that does exist indicates a lack of integration.

A survey study that collected data in 2017 and 2018 and involved members of the Global Consortium on Climate and Health Education (GCCHE) was aimed at understanding the current state of climate-related health education in health profession institutions curricula internationally. ⁽¹⁵⁾ The GCCHE consists of 298 member institutions globally, which includes several institutions in Africa and South Africa. ⁽⁶¹⁾ In South Africa, member institutions include the University of Cape Town's School of Public Health and Family Medicine and Stellenbosch University's Department of Nursing and Midwifery. ⁽⁶¹⁾ An invitation to take part in the survey was sent to 160 member institutions. The study sample included 84 institutional members of the GCCHE, of which 70% were from public health, health sciences, or health professions; 18% were from medicine; 11% from nursing; and 1% from another type of health institution. ⁽¹⁵⁾ Results showed that climate-related health education in the medical schools' curricula was much lower than that compared to the sampled group as a whole. While 63% of the sample offered climate-health education, only 23% of the medical schools included in the study offered aspects of climate and health as part of their curriculum. ⁽¹⁵⁾ Of the institutions that had integrated climate-related health education into the curriculum, 76% offered a session on climate change as part of a required core course, 44% offered a standalone elective, and 39% offered a non-required course. ⁽¹⁵⁾ Notwithstanding the small percentage of medical schools in the study that offer climate-related health education, most (61 of 82, 74%) of the institutions reported that the inclusion of climate change and health offerings in international health professions curricula and programs is currently under discussion ⁽¹⁵⁾ alluding to a possible growing interest and motivation to include the topic in medical curricula in South Africa. It should be noted that the sample was drawn using convenience methods and the sampling frame included institutions that are self-selected members of the GCCHE. As a result, the sample is vulnerable to self-selection bias in that those institutions that agreed to participate in

the research may have already offered or were planning to offer climate-related health education in their curriculum. Furthermore, authors did not disclose which member institutions agreed to participate in the study and therefore it is not known which regions are represented in the results.

A more recent survey, conducted between March 2019 and March 2020, this time involving undergraduate medical students from the International Federation of Medical Students' Association (IFMSA)-affiliated medical schools, showed a similar lack of integration of the topic in their medical curricula.⁽¹²⁾ The IFMSA is one of the largest student-organisations, with 139 member organisations in 130 countries around the world. Several countries on the African continent, including South Africa, are affiliated with IFMSA. The survey aimed to assess the inclusion of climate-related health and air pollution education in medical curricula. Results showed that in a sample of 2817 medical schools in 112 countries, ~31% had no element of climate change and health in the mandatory or informal curriculum; ~21% had a non-mandatory or student-led lecture on climate change and health; ~14% dedicated a session, lecture or case study on climate change and health in one year of the curriculum; ~14% dedicated a session, lecture or case study on climate change and health every year of the curriculum; and ~20% included climate change or environment and health as part of a teaching session.⁽¹²⁾ Concerning air pollution, only 11% of the sampled schools had included formal education on the topic in their curriculum.⁽¹²⁾ A strength of this study is that the authors provided a list of the countries that were included in the sample and thus represented in the results. However, it should be noted that the study collected medical students' perceptions and therefore the results should not be misinterpreted as an objective reflection of the inclusion of climate change and health in medical curricula but rather the subjective opinions of medical students.

A mixed-methods study conducted in 2021, to examine the design and delivery of climate change and health in Master of Public Health (MPH) and medical degree programs in tertiary institutions in Australia and New Zealand, produced similar results.⁽¹⁶⁾ Participants included 21 educators involved in the development and implementation of climate change-related health curricula. Eight participants were from public health, nine from medicine, two from planetary health and health sciences, and two indicated that they do not directly convene courses. The majority of the participants indicated that less than 5% of the degree lecture and assessment content focussed on climate-related health, which was most often integrated into an existing program rather than offered as a standalone course.⁽¹⁶⁾ The authors advised against the generalisation of the results due to possible non-response bias based on the 43% response rate and small sample size obtained in the study.⁽¹⁶⁾ Furthermore, due to sample self-selection, it is likely that those educators who did participate in the study may also be progressively more active in the integration of climate-related health education in curricula.⁽¹⁶⁾

Educators seem to prioritise similar aspects of climate change and health to include in the curriculum. When asked to describe the main goals of their climate-related health curriculum, member institutions of the GCCHE mentioned the importance of an improved understanding of the science and factors causing

climate change, the relationship between climate change and health, how to analyse health risks, and skills to identify vulnerable populations. ⁽¹⁵⁾ They also addressed the HCPs' role as an advocate for climate change and suggested the importance of understanding climate change-health policies, understanding how to instigate behaviour change and advocacy for sustainable healthcare, and improving climate change and health communication skills. ⁽¹⁵⁾ Educators in Australia and New Zealand also mentioned the importance of including information about the health effects of climate change, adaptation and mitigation solutions – including health policy and advocacy, environmentally sustainable healthcare, and pathways through climate change impacts on health. ⁽¹⁶⁾ Other topics included aspects of the healthcare sector's impact on climate change, the interconnectedness between the global environment and social drivers (poverty and inequality), and indigenous perspectives on climate change and health. ⁽¹⁶⁾

Educators recommend several strategies on how to integrate climate-related health into medical curricula. These include solution-based, engaging, and thought-provoking discussions; direct interactions with expert guest speakers; online discussion forums; and discussions of contemporary evidence and assessments that focus on critical thinking. ⁽¹⁶⁾ In another study, conducted in the United Kingdom, Tun (2019) used a grounded theory approach, in which multiple data sources (including a document review, meetings with stakeholders, and interviews with medical educators) were triangulated to examine how best to integrate climate change-related health education in medical curricula. The author discusses a possible bias in the study towards climate-related health education as the key informants in the study were all enthusiasts for sustainable healthcare education, which could have, for example, influenced their barrier perceptions. ⁽⁶²⁾ Tun (2019) also reflects on their own position on sustainable healthcare education, which could have resulted in researcher bias. However, they report that steps were taken to remain reflexive throughout the research process to uphold the trustworthiness of the data. ⁽⁶²⁾ Participants in the study recommended integrating the topic as a cross-cutting theme rather than a standalone topic, allowing learners and teachers to learn from each other (in this developing field), relating teaching to the clinical setting, using multiple pedagogies for teaching, and supporting emotional resilience to deal with this overwhelming topic. ⁽⁶²⁾

The integration of climate-related health education into healthcare curricula has however been limited by several factors. Many members of the GCCHE expressed barriers to the integration of climate-related health education in the curriculum. ⁽¹⁵⁾ These barriers included a lack of staff time, a lack of funding, competing institutional priorities and politics, a lack of space in the curriculum, teaching materials and staff expertise, a lack of interest and demand from students, and administrative or other scepticism about climate change-health science. ⁽¹⁵⁾ Similarly, when asked about limitations to the inclusion of climate-related health education in MPH and medical degree programs in Australia and New Zealand, participants discussed limitations of time, resources, and interest from students and other decision-makers. ⁽¹⁶⁾ These findings were echoed by medical educators in the United Kingdom who mentioned that integration was

limited by a lack of knowledgeable teachers of sustainable healthcare, available space in the curriculum, uncertainty about where to integrate the topic into the curriculum, a need for learning resources, difficulty in assessing learning, and a necessity to teach emotional resilience to cope with the overwhelming topic. ⁽⁶²⁾

Several factors however also seem to be working in favour of the integration of climate-related education in medical curricula. When asked what they found helpful in developing or introducing climate change-related health education in the curriculum, members of the GCCHE mentioned that interest from students, faculty, and administration, and support from donors facilitated the process. ⁽¹⁵⁾ Similarly, medical educators in the United Kingdom identified key facilitators to the integration which included a demand from students and a shift towards a focus on sustainability in higher education. ⁽⁶²⁾ This highlights the importance of perceptions about climate change and health to reduce the barriers to the development and integration of climate-related health education in medical curricula.

The evidence suggests that, globally, there is a lack of integration of climate-related health education in medical curricula. In the next section, I provide an overview of the literature describing the perceptions of students and HCPs as they relate to climate change and health and climate-related health education.

Perceptions of climate change and health

As the number of publications related to climate change and healthcare facilities increases ⁽²³⁾ it seems HCPs' engagement with the topic is increasing. ⁽⁶⁰⁾ Current literature seems to be concentrated in high-income countries (HICs), particularly the United States (US). However, while there seem to be fewer studies from low-resource settings, the results from these studies are mostly similar in that health sciences students and HCPs recognise the link between climate change and health, feel inadequately prepared to respond to them in clinical practice and suggest increased integration into medical curricula. What follows is an overview of the literature describing health sciences students' and HCPs' perceptions as they relate to climate change and health.

Hampshire et al. (2021) conducted a survey study that involved 600 medical students from 12 medical schools across the US to explore their perceptions of climate-related health education in medical curricula. Results indicated that participants believed that climate change will affect the health of their future patients as well as their own health and that physicians should know about climate change and its health impacts for clinical practice. ⁽⁹⁾ The majority of the participants also felt that climate change and health should form part of the core medical curricula and that their current curriculum does not adequately prepare them to respond to the health impacts of climate change. ⁽⁹⁾ This finding is similar to what was found in other survey studies involving medical, nursing, and physician students at Yale University ⁽⁶³⁾ and primary care physicians in West Michigan ⁽⁶⁴⁾ in that they recognise a gap in their medical education and training and believe that they are not adequately prepared for the health impacts of climate change in their current or future clinical roles. Most (90%) of the sample of medical, nursing, and physician students (n =

280) from Yale University also indicated that they believe that HCPs have a responsibility to conserve resources and mitigate air pollution in their clinical practice. ⁽⁶³⁾ It should be noted that these studies used convenience sampling techniques to obtain their samples, making them vulnerable to self-selection bias, and the response rates in all three studies were also low, ranging between 13.4%⁽⁹⁾ and 28%. ⁽⁶³⁾ The generalisability of the results can therefore not be assumed.

Three to five-year medical students (n = 170) from the Heidelberg medical faculty in Germany, shared this belief that physicians have a responsibility to address climate change and health in clinical practice. ⁽¹⁰⁾ However, only 4.71% of the sample believed that the medical training they had received so far had sufficiently prepared them to address climate change and health and climate change mitigation in their future work as physicians. ⁽¹⁰⁾ A large majority (79.4%) of the participants indicated that climate change and health should be integrated into medical curricula. ⁽¹⁰⁾ The authors, however, note that the study is vulnerable to self-selection bias as more than half (58%) of the sample indicated that they voted for the Green Party, suggesting that those who hold less pro-environmental attitudes may have been less likely to participate in the research and thus that the role perception of medical students may be overestimated. ⁽¹⁰⁾

In Italy, a cross-sectional survey study was conducted at Sapienza University in Rome involving 364 participants (students and professionals of the medical healthcare setting) to assess their knowledge of climate change and its related consequences. A large majority (97.7%) of the participants, of which the majority (63.7%) were medical students, believed that climate change impacts human health and 93.4% believed that HCPs could help reduce the impacts of climate change on health. ⁽⁶⁵⁾ While the sample was drawn using convenience methods, it should be noted that the response rate was relatively high (64.2%) in comparison to other studies on the topic, thus possibly suggesting less bias due to nonresponse.

Kotcher et al. (2021) conducted a multi-national survey study to explore HCPs' views on climate change and health. ⁽¹¹⁾ The sample consisted of 3977 HCPs from 12 health professional associations globally. Results indicated that the majority (66%) of the participants believed that climate change would cause harm to them personally and 77% believed that climate change would harm the health of their patients. ⁽¹¹⁾ In line with other studies, the majority of the sample believed that HCPs have a responsibility to address climate change and health. ⁽¹¹⁾ Participants believed that besides addressing climate change and health in their clinical practice, HCPs also have the responsibility to bring climate change-related health matters to the attention of the public and to advocate for increased investment in health, but they indicated that they need more information and guidance to do so. ⁽¹¹⁾ While the study obtained a relatively large sample size, it should be noted that the response rate in many nations was low and varied between 0.4% from the British Medical Association to 22.5% from the Canadian Medical Association. This could be due to the study collecting data during the COVID-19 pandemic when it can be expected that many HCPs were unusually busy. ⁽¹¹⁾ As a result, the authors advise that the findings are not necessarily generalisable to the full membership of societies that participated in the study. ⁽¹¹⁾ The majority of the participants (n = 2852) came

from the Canadian Medical Association followed by 385 participants from the Indian Academy of Pediatrics and 334 participants from the South African Medical Association. ⁽¹¹⁾

Medical students and HCPs from lower-income countries seem to have similar perceptions about climate change and health. In India, a cross-sectional survey involving 903 medical students found that most students were aware of the health impacts of climate change and saw it as a current and future problem. ⁽⁶⁶⁾ Participants recognised a link between climate change and cardiovascular and respiratory diseases, increased infectious vector-borne disease transmission, and forced migration and civil conflicts. ⁽⁶⁶⁾ In contrast to what has been found in other studies, most participants reported having adequate knowledge about climate change and following climate-friendly behaviours, such as switching off lights and using energy-saving appliances. ⁽⁶⁶⁾ Authors also found that climate-friendly behaviours (such as using energy-saving products and recycling waste) were higher amongst those participants who reported adequate climate change knowledge in comparison with those who reported inadequate climate change knowledge and the differences were significant ($p < 0.05$) ⁽⁶⁶⁾ It should, however, be noted that the study measured self-perceived knowledge by asking participants to agree or disagree with questions such as “Do you know the causes of climate change?” and self-perceived climate-friendly behaviours by asking participants to report on their climate-friendly behaviours. In other words, actual behaviour was not measured. While inferences about the relationship between knowledge and behaviour can therefore not be made, it is interesting to note that increased self-perceived knowledge was associated with increased self-perceived climate-friendly behaviours, as it suggests that raising awareness about climate change and health in HCPs, by including it in medical curricula, could inspire climate change mitigative and adaptive behaviours.

In another study conducted across India, involving a large sample ($n = 3062$) of HCPs, including medical doctors, the authors report that the majority of the participants recognise the impact of climate change on health. ⁽⁶⁷⁾ Most of the doctors in the sample expressed an interest in learning more about climate change and health to address these challenges in clinical practice (81.2%) and believed that climate change should be included in healthcare curricula (77.8%). ⁽⁶⁷⁾ It should however be noted that the sample was not randomly drawn and therefore it is vulnerable to selection bias, which could have resulted in inflated ideas about climate change. Furthermore, to increase the response rate, the survey was administered telephonically, in-person, and online. As a result, the study is also vulnerable to desirability bias, which could have impacted responses to questions about attitudes about climate change and possibly explain why most doctors expressed an interest in learning more about climate change.

In the first nation-wide survey of climate change and health conducted amongst medical students in China, which involved 1387 senior medicine, public health, and nursing students, the majority (~90%) of the participants believed that climate change was detrimental to human health. ⁽⁶⁸⁾ Approximately 90% of the participants also felt a responsibility to address the health impacts of climate change and believed that their expertise and skills could play an integral part in doing so. ⁽⁶⁸⁾ However, only half of the participants

felt adequately skilled and experienced to fulfil this role and 79.8% said they did not have the necessary knowledge to address the health-related impacts of climate change. ⁽⁶⁸⁾ Majority of the participants believed that climate-related health education, with a specific focus on clinical knowledge and skills (71.0%), population health (61.6%), and emergency care (59.4%), should form part of medical curricula. ⁽⁶⁸⁾ It should be noted that this is one of the few studies on the topic that applied random sampling techniques to draw a sample for the study. However, the authors warn against generalising the results as they included only esteemed universities and medical students from other universities could have lower perceptions of climate change and health. ⁽⁶⁸⁾

In Ethiopia, two studies were found that explored HCPs' and health science students' perceptions of the health impacts of climate change and disaster preparedness. ^(69,70) In both studies, participants believed that climate-related disasters have a detrimental impact on human health and indicated a need for additional training on disaster preparedness. ^(69,70) Nigatu et al. surveyed health science students at Haramaya University in Ethiopia in which they collected information about students' knowledge, perceptions, and awareness of the relationship between climate change and health. ⁽⁷⁰⁾ A sample was drawn from the entire population of students using a proportionately stratified procedure to enhance representation across subgroups of the student population. The authors found a significant association between students' awareness of climate change and a perceived departmental concern for preventing the public health consequences of climate-related health impacts. Those students who knew about climate change were more likely to perceive the prevention of climate change health impacts as a departmental objective than those who knew less about climate change ($X^2 = 21.6$, $df 2$, $P < 0.05$). ⁽⁷⁰⁾ They also found that those students who knew more about climate change were 14 times more likely to understand the health impacts of climate change than those students who did not know about climate change (OR: 14.1, 95% CI: 5.1 – 38.6). ⁽⁷⁰⁾

Climate-related health education in South Africa

Research exploring the perceptions of HCPs and medical students in South Africa, as they relate to climate change and health and climate-related health education, is sparse. A total of three studies were found that explored the topic, however, one of these studies also included the perceptions of students from faculties other than health sciences, which makes it difficult to discern medical students' perceptions from the rest of the sample. In that study, 90 university students from an unnamed rural university in South Africa were surveyed to assess the extent to which they understood climate change impacts. ⁽⁷¹⁾ The sample was drawn using convenience methods and as a result, the study is vulnerable to selection bias. The sample included mostly undergraduate level students and 66% came from health sciences, 27% from science and agriculture, and 7% from humanities. ⁽⁷¹⁾ It is not clear how many, if any, of these students were medical students. While the results were still mostly in line with existing literature on the topic in that students recognised the impact of climate change on health and believed that their communities are vulnerable to

these impacts, ⁽⁷¹⁾ it should be noted that the authors indicated that the study is conducted from the social constructivist paradigm, which brings into question the validity of using quantitative methods and thus the validity of the findings.

In 2022, Manga et al. conducted a national survey, collecting the views of South African HCPs as they relate to climate change, climate change's impact on diseases, and healthcare systems preparedness. ⁽⁷⁾ HCPs from public and private hospitals were eligible to participate in the study and the questionnaire was shared via hospital and clinical social media groups and email lists. The sample included 234 participants of which 87% were medical doctors and 2% were medical students. ⁽⁷⁾ The balance was made up of allied professionals, nurses, and other HCPs. Results indicated that a large majority (93%) of the sample believed that climate change would harm them, their patients, and their communities. ⁽⁷⁾ The majority of the participants believed that climate change will severely impact malnutrition and foodborne diseases (62%) and waterborne diseases (60%). ⁽⁷⁾ Other concerns included extreme weather events, respiratory illness, zoonotic infections, vector-borne diseases, and mental health. ⁽⁷⁾ Interestingly, only a small portion (17%) of the sample recognised the link between non-communicable diseases (NCDs) and climate change, ⁽⁷⁾ which possibly points to a lack of understanding of the complex pathways of climate change and health. The majority (81%) of the sample did not know if or how the facility they worked at was preparing to respond to climate change and 79% felt that their facility should be doing more. ⁽⁷⁾ This study however did not explore HCPs' perceptions about their level of preparedness and training and education needs. It should also be noted that, as with many of the other studies included in this review, due to sample self-selection, which could have led to non-response bias, these views may be biased towards those who have an interest in climate change and health. This highlights the need to use random sampling methods in future research to reduce this possible bias.

In a most recent study by Irlam et al. (2023), faculty of health sciences (FHS) undergraduate students from the University of Cape Town, South Africa, were surveyed to explore their knowledge and perceptions regarding climate change and environmental sustainability. ⁽⁷²⁾ All FHS students were invited to participate in the study via email from the FHS office and 20 vouchers for a local café were randomly awarded to incentivise participation. A total of 264 students completed the survey (12.6% response rate) of which 80% were medical students and 20% were health and rehabilitation science students. The majority (64.4%) of the participants indicated that they were aware of climate change but had a limited understanding of the issue. ⁽⁷²⁾ Amongst the medical students, understanding of climate change seemed to increase with years of study, that is, those who were in the 5th and 6th year had a better understanding of climate change compared to those in the 3rd and 4th year of study ⁽⁷²⁾ This could be because, in South Africa, aspects of environment and health are included in the 4th year medical curriculum when students are trained to identify health risks associated with environmental impacts and socio-economic status. ⁽⁷³⁾ Approximately two-thirds (64%) of the sample thought that climate change will have a high impact on the health of their

future patients and health concerns were mostly due to extreme weather events or natural disasters (94.7%), respiratory illnesses (92.4%) water-borne diseases (91.7%), malnutrition (81.4%), vector-borne diseases (76.9%), and mental illness (65.5%).⁽⁷²⁾ Interestingly, only 28% of the sample considered heat-related illnesses to have an impact on health,⁽⁷²⁾ despite data showing that South Africa has been experiencing an increase in extremely hot days.⁽⁴³⁾ In line with previous findings, this could indicate a lack of understanding of the complex pathways of climate change and health.

With regards to climate change and environmental sustainability in the FHS UCT curricula, Irlam et al. (2023) suggest that current FHS students, in particular medical students, are not receiving adequate training and education as part of their undergraduate studies to address the health impacts of climate change. Just over half (51.5%) of the sample indicated that the current FHS curricula pay little attention to climate change and environmental sustainability, with the medical students agreeing significantly more with this statement than the health and rehabilitation sciences students (54.5% v. 39.6%; $p=0.05$).⁽⁷²⁾ It is important to remember that this finding is based on students' perceptions and should not be misinterpreted as an objective reflection of the current FHS curricula. Students recommended facilitated group discussions, peer-to-peer discussions, online interactive resources, case studies, and electives as the mode of teaching for climate change -related health education. Suggested topics to be included in the curricula were the impacts of climate change on health, living a sustainable lifestyle, mitigation of climate change impacts, and adaptive strategies.⁽⁷²⁾ As with many other studies discussed in this review, this study is vulnerable to self-selection bias due to the convenience method of sampling that was used.

It is important to note that, while it can be reasonably expected that climate change will have a big impact on emergency healthcare, none of these studies specifically focussed on emergency medicine specialists nor is it clear whether this group was included in any of the samples. Few studies on the African continent have focussed on emergency healthcare preparedness to respond to the health impacts of climate change⁽²⁵⁾ and, to my knowledge, no studies exist that focus on the perceptions of emergency medicine specialists' on the topic. To ensure that emergency healthcare is appropriately prepared to respond to these expected impacts, it is imperative to ensure that healthcare professionals who work in EDs are appropriately trained to address the needs of the communities they serve in the face of climate change.

This study therefore focussed specifically on emergency medicine registrars and physicians in South Africa to create an understanding of their perceptions of and preparedness to respond to climate change-related health impacts. An understanding of this could help create a sense of the education and training needs of emergency medicine specialists in South Africa that in turn could be applied to enhance preparedness for climate-related health concerns and emergencies, thereby reducing vulnerability in populations that are already burdened.

Chapter 4: Methodology

Statement of the research problem

Climate change is predicted to significantly impact human health. ⁽¹⁻⁵⁾ Emergency healthcare, with its focus on acute care, is often at the forefront of the response to climate-related health impacts. It is therefore imperative that emergency medicine specialists understand what climate-related impacts to expect and to be sufficiently trained to appropriately respond to these impacts. However, globally, very little to no information exists about emergency medicine specialists' understanding of and preparedness to respond to the health impacts of climate change.

Research purpose

This study aimed to describe emergency medicine registrars' and physicians' perceptions of climate change and health, climate-related health education, and self-perceived preparedness to respond to these impacts.

Research objectives

- **Objective 1:** To describe perceptions related to the health impacts of climate change.
- **Objective 2:** To describe self-perceived preparedness to respond to the health impacts of climate change.
- **Objective 3:** To describe perceptions, level of engagement, and expectations related to climate change in medical education and training.
- **Objective 4:** To describe the perceived priorities to focus on that are expected to increase preparedness to respond to the health impacts of climate change.

Methods

To achieve these objectives, this study followed a cross-sectional descriptive survey design. A survey design provides quantitative data on attitudes, trends, and characteristics of a population by studying a sample from that population. ⁽⁷⁴⁾ The study was cross-sectional, meaning that the data of each participant were collected once, and data collection took place over a short period. Data were collected online, which made it possible to reach emergency medicine registrars and physicians across South Africa. The questionnaire was self-administered, which allowed participants the opportunity to complete the survey at a time that was convenient to them and in private. It is expected that this may have decreased desirability bias as questionnaires were also anonymous. The data were extracted into Excel and analysed descriptively to address the research objectives.

Sampling

Population

The study was conducted nationally in South Africa. Emergency healthcare in South Africa is delivered at two levels: pre-hospital and facility-based (or in-hospital) care. For this study, we focussed on facility-based emergency healthcare that is provided in EDs in private and public healthcare facilities.

Emergency medicine is a relatively new speciality in South Africa and was first registered in 2003. ⁽⁷⁵⁾ The Division of Emergency Medicine at the University of Cape Town was the first to offer the Master of Medicine in Emergency Medicine (MMed) programme, ⁽⁷⁵⁾ which is now being offered at several Universities across the country. Emergency medicine specialist training includes 4 years of 3-month blocks consisting of emergency medical services, intensive care, obstetrics and gynaecology, internal medicine, surgery, and paediatrics. ⁽⁷⁵⁾ The balance of the time is spent in EDs.

Emergency medicine specialists work in EDs to provide treatment to patients who need immediate care. The sampling frame included all emergency medicine registrars and physicians who, at the time of the study, were registered with the Health Professions Council of South Africa (HPCSA) either as an emergency medicine registrar or an emergency medicine physician. At the time of data collection, there were approximately 200 emergency medicine registrars and physicians registered with the HPCSA.

Sampling procedures

A sample was drawn from a population of emergency medicine registrars and physicians studying or working in South Africa at the time of data collection. A convenience sample was drawn by distributing an invitation to participate in the study using email, WhatsApp, and Twitter. See Appendix A. The following special interest groups were also contacted via email to distribute the invitation to their members: Emergency Medicine Society of South Africa (EMSSA) and Emergency Care Society of South Africa (ECSSA). Recipients of the invitation could share it with other prospective participants, who were then able to access the survey online by following the link that was included in the invitation.

Sample size

The required sample size is often based on the statistical analyses that will be used. As a general rule of thumb, for descriptive analysis, using means and frequencies to describe the data, nearly any sample size is sufficient. ⁽⁷⁶⁾ According to Gay and Diehl (1992), for descriptive research, a sample size of 10% to 20% of the population is adequate. ⁽⁷⁷⁾ Therefore, based on this recommendation, and the population size of 200 registrars and physicians, a sample size of 20 to 40 participants would suffice.

Data collection procedure

Data were collected using a self-administered questionnaire that was placed on Google Forms (Google Inc., California, US). Data collection took place over 3 months (March 2023 to May 2023).

Measuring instrument

Data were collected using a 26-item questionnaire consisting of a combination of 29 Likert-type, multiple-choice, binary, or free-text questions. The questionnaire was in English, which is the primary medium of instruction in medical school curricula in South Africa. See Appendix B. The questionnaire consisted of four parts, collecting participants' 1) biographical information, 2) perceptions of climate change as a potential threat to health, 3) perceptions about climate change as part of medical education and training, and 4) self-perceived preparedness to respond to the health impacts of climate change.

Seven questionnaire items were borrowed from an existing survey, with the approval of the authors, and adapted to align with the emergency healthcare focus of the study.⁽⁹⁾ For example, the term 'physician' was replaced with 'emergency care provider' and answer options were expanded to include postgraduate medical specialist training. The questionnaire took approximately 15 to 20 minutes to complete.

The first part of the questionnaire collected biographical information of the participants. This section consisted of questions 1 to 9. Demographic data that were collected included medical school attended, graduation date from medical school, years active as a medical professional, graduation date or expected graduation date as an emergency physician, province currently working in, date of birth, and gender.

A short definition of anthropogenic climate change and its associated impacts on the natural environment was then shown to the participants before they could continue to the second part of the questionnaire. The description read as follows: "*Climate change refers to a long-term change in the Earth's average temperature and weather patterns. Whilst these shifts may be natural, certain human activities are causing these changes to accelerate resulting in human-induced climate change. Human-induced climate change has led to changes in natural systems, such as changes in precipitation patterns, acidification of oceans, melting of glaciers, and changes in the behaviour and ecology of species and ecosystems.*^(1,27,28) *In turn, these changes are causing sea levels to rise, changes in the distribution of vector-borne diseases and pathogens, and an increase in the frequency and intensity of extreme weather events, such as floods, droughts, and heat waves.*⁽¹⁾ "

The second part of the questionnaire collected data about participants' perceptions of climate change as a potential threat to health. This section included seven questions that ranged from questions 1 to 3B and consisted of Likert-type, multiple-choice, and open-ended questions. Questions such as: "*Do you think there is a link between climate change and health?*" and "*In what way do you think these climate change*

variations could impact health?" measured participants' perceptions of the health impact of climate change on both their and their patients' health in the future.

The third part of the questionnaire collected data about participants' perceptions of climate change as part of medical education and training. This section included six or seven questions, depending on participants' answers, that ranged from questions 4 to 9. Items consisted of Likert-type, binary, multiple-choice, and open-ended questions. Questions such as: *"Did you receive formal training surrounding the health impacts of climate change during medical school?"* and *"Do you think that you received enough formal training surrounding the health impacts of climate change?"* collected data about participants' engagement and expectations as it relates to climate change curriculum in medical education and training.

The final part of the questionnaire collected data about participants' self-perceived preparedness to respond to the health impacts of climate change. This section included six questions ranging from questions 10 to 14. Items included Likert-type, multiple-choice, and open-ended questions. Questions such as: *"If a patient asked you, 'how can climate change impact my health?', how prepared would you feel to engage in a conversation with them?"* and *"In your opinion, what are the main priorities to focus on that will increase preparedness to respond to the health impacts of climate change?"* collected data about participants' self-perceived preparedness to respond to the health impacts of climate change.

Data analysis

Data capturing

The data were recorded using Google Forms (Google Inc., California, US) and later extracted into Microsoft Excel (Microsoft Corporation, Washington, US) for data cleaning. There were no missing data points and as such no entries were removed. Each participant was assigned an identification number. The data set was then imported into the Statistical Package for the Social Sciences (SPSS, IBM, Version 28, New York, US) for analysis.

Data analysis

The data were analysed using the following techniques.

Descriptive analysis

Biographical data were analysed descriptively. Continuous data (year of birth, year graduated from medical school, year graduated/-ing as an emergency physician, years working in the health sector, and years working in the emergency department) are reported in terms of minimum, maximum, median and interquartile range (IQR) statistics. Categorical data (gender, medical schools attended, province currently employed in) are reported in terms of frequencies and percentages.

Data produced from Likert-type questions were analysed descriptively and results are reported using percentages, medians, and IQRs. Multiple choice responses were counted and ranked, where applicable, and reported in terms of frequencies and percentages. Responses to the binary question were counted and reported using frequency and percentage. Free-text responses were analysed inductively following Elo & Kyngäs' (2008) recommendations on how to conduct quantitative content analysis.⁽⁷⁸⁾ The results were compiled to address the research objectives.

Exploratory analysis

Mann-Whitney U tests were conducted to determine if any group differences exist between sub-groups of the sample (e.g., gender and age) with regards to the dependent variables in the study (e.g., perceptions about the health impact of climate change). A Mann-Whitney U test is used to explore group differences when the dependent variable is either ordinal or continuous, but the data is not normally distributed.

Validity

The content validity of a questionnaire refers to how representative the questions contained in the test are of the phenomenon or topic being studied.⁽⁷⁹⁾ Determining content validity follows a formal assessment by subject experts to determine the appropriateness and completeness of the content and to highlight possible misunderstandings.⁽⁸⁰⁾ The questionnaire was pilot-tested by three healthcare experts prior to data collection to determine content validity. Two of the experts are emergency medicine specialists and the third expert specialises in climate-related health education in health sciences curricula. All three experts are practising in South Africa.

This survey collected information about participants' perceptions and opinions. This could present a threat to the validity of the study if participants responded to questions in a manner that is perceived as socially acceptable. It can however be expected that participants would respond truthfully about their perceptions and opinions provided that no strong social desirability or sensitivity exists about the topic when the researcher is not directly involved with data capturing (i.e., self-administered questionnaire), and the questionnaire does not collect identifiable information.⁽⁸¹⁾ In which case it can be assumed that in this study the participants would have likely responded with honest answers to the survey questions.

Ethical Considerations

The project commenced after ethical approval was obtained from the Human Research Ethics Committee (HREC) of the University of Cape Town (HREC REF 065/2023).

In line with the principles of autonomy, justice, non-maleficence, and beneficence, this study ensured ethical practice by implementing the following steps.

Prospective participants were informed that by clicking the “Agree” button at the bottom of the landing page of the questionnaire, they agree that they have read the information on that page and they consent to take part in the study. See Appendix C. Prospective participants were assured that they were under no obligation to participate in the project and had the freedom to withdraw from the study at any point prior to submitting the survey without any repercussions. Participants remained anonymous throughout the project by not collecting any identifiable information from them. Results are also reported as a collective and not on an individual basis.

The collected data on Google Forms were exported to Microsoft Excel and stored on a password-protected personal computer, to which only I have access. The data will be kept for a minimum of five years for auditing purposes. Only the research team will have access to the data.

There were no anticipated risks to the participants of the study beyond possible slight inconvenience due to the time it took to complete the survey. However, participation in the study was voluntary, the survey took no more than 20 minutes to complete, and participants were able to complete the survey at their convenience. There were also no anticipated risks to groups of the population who did not take part in the research. Participants will not directly benefit from taking part in the study. However, there may be indirect benefits to the participants and other emergency healthcare workers as the study will likely contribute to an increased focus on climate change preparedness as it relates to emergency healthcare.

The dissertation that is produced will be published in OpenUCT, an open-access institutional repository of the University of Cape Town. A report of the results will be sent to the MMed course convenors who will be asked to share it with their current students and alumni. We will also seek publication in an open-access journal.

Chapter 5: Results

This study aimed to describe emergency medicine registrars' and physicians' perceptions of climate change and health, climate-related health education, and self-perceived preparedness to respond to these impacts. The study followed a quantitative, survey design to collect data about participants' perceptions and opinions. This chapter contains the research findings.

Study participants

A total of 20 participants completed the questionnaire. Participants' year of birth ranged from 1967 to 1993 (Mdn = 1989, IQR = 3), with two-thirds (65%, n = 13) identifying as women and seven (35%) identifying as men. Five (25%) participants reported having graduated as emergency physicians before 2023 and participants' years of graduation from medical school ranged from 1993 to 2018 (Mdn = 2013, IQR = 4). Years working in the health sector ranged from 5 to 29 years (Mdn = 10.00, IQR = 2) and years working in the ED ranged from 2 to 26 years (Mdn = 7.50, IQR = 4). The majority of the sample is currently working in the Western Cape Province (75%, n = 15), 4 participants (20%) are working in Port Elizabeth, and 1 participant (5%) is working in Gauteng.

Half of the participants received medical training at the University of Pretoria (25%, n = 5) or the University of Cape Town (25%, n = 5) and half (50%, n = 10) of the participants completed or are currently enrolled for their Master of Medicine (MMed) degree at the University of Cape Town (i.e., registrars). Information about the medical schools that participants attended is contained in Tables 1 and 2 below.

None of the participants received formal training surrounding the health impacts of climate change during medical school and the majority (95%, n = 19) of the participants indicated that they had no, or a low level of engagement related to climate change during medical school.

Table 1. Medical schools at which the participants were enrolled for their undergraduate degree

	<i>Frequency</i>	<i>Percentage</i>
SUN	4	20%
UCT	5	25%
UL	1	5%
UP	5	25%
UFS	2	10%
WITS	1	5%
UN	1	5%
UKZN	1	5%
Total	20	100%

*See note below for key

Table 2. Medical schools at which the participants are or were enrolled for their MMed degree

	<i>Frequency</i>	<i>Percentage</i>
SUN	6	30%
UCT	10	50%
UP	1	5%
WITS	2	10%
Grandfathered**	1	5%
Total	20	100%

*Note. SUN = Stellenbosch University, UCT = University of Cape Town, UL = University of Limpopo, UP = University of Pretoria, UFS = University of the Free State, UN = University of Nairobi, UKZN = University of KwaZulu Natal, WITS = University of the Witwatersrand. **Accepted into the speciality preceding the availability of specialist training ^(75,82)

Objective 1: Describe perceptions related to climate change and health.

The majority (80%, n = 16) of the participants indicated that there is probably or definitely a link between climate change and health and felt that climate change will affect the health of their future patients. The majority (75%, n = 15) of the participants agreed or strongly agreed that climate change currently impacts population health outcomes and 70% (n = 14) of the sample agreed or strongly agreed that climate change will affect their personal health. The majority (85%, n = 17) of the sample felt that emergency care providers should know about climate change and its health impacts on clinical care.

When asked to choose the top three climate change impacts of concern for their province from a list of 10 options considered likely impacts in South Africa ⁽⁴³⁾ and an additional free-text option, most participants chose increased severity of drought (n = 9), not enough food (n = 9), changes in the geographic spread of vector-borne diseases (n = 8) and increased fire risks (n = 8). Participants who are currently employed in Gauteng province rated changes in the geographic spread of vector-borne disease as their top concern (n = 3) and participants who are currently employed in the Western Cape province rated rising sea levels and inadequate supply of food as their highest concerns (n = 7, respectively). A summary of the participants' perceptions regarding the health impact of climate change is provided in Table 3 below.

Table 1: Perceptions among emergency registrars and physicians regarding climate change's health impacts

<i>Questions and Responses</i>	<i>Frequency</i>	<i>Percentage</i>
<i>Do you think there is a link between climate change and health?</i>		
Definitely not	0	0
Probably not	0	0
Neutral	4	20%
Probably	3	15%
Definitely yes	13	65%
<i>Please rate the extent to which you agree/disagree with the following statements:</i>		
<i>Climate change currently impacts population health outcomes.</i>		
Strongly disagree	0	0
Disagree	0	0
Unsure	5	25%
Agree	4	20%
Strongly agree	11	55%
<i>Climate change will affect the health of my future patients.</i>		
Strongly disagree	0	0
Disagree	0	0
Unsure	1	5%
Agree	6	30%
Strongly agree	13	65%
<i>Climate change will affect my personal health.</i>		
Strongly disagree	1	5%
Disagree	2	10%
Unsure	3	15%
Agree	7	35%
Strongly agree	7	35%
<i>Emergency care providers should know about climate change and its health impacts for clinical practice.</i>		
Strongly disagree	0	0
Disagree	1	5%
Unsure	2	10%
Agree	5	25%
Strongly agree	12	60%

Participants were able to add free text about the way they think these climate change impacts could influence health. All 20 participants responded to this question. Approximately two-thirds (65%, n = 13) of the participants indicated that they expect *“changing patterns of disease”* (Participant 11, man, 8 years working in ED). Other expected changes included increased malnutrition due to *“disruption of (the) food chain and food production due to weather..”* (Participant 2, woman, 3 years working in ED); increased climate change-related emergencies such as *“floods leading to drowning incidents”* (Participant 3, woman, 8 years working in ED); *“increased (infectious) disease, e.g., diarrhoea outbreaks secondary to both drought and low dam levels and floods”* (Participant 9, woman, 7 years working in ED); and *“increase in respiratory illnesses from (air) pollution”* (Participant 5, woman, 4 years working in ED).

Objective 2: Describe self-perceived preparedness to respond to the health impacts of climate change.

To gain an understanding of participants’ self-perceived preparedness to respond to the health impacts of climate change, they were asked to rate how prepared they felt to engage in a conversation with a patient asking about the health impacts of climate change. Fifteen per cent (n = 3) of the participants indicated they felt quite or very prepared while 45% (n = 9) indicated they were not at all or very little prepared. Half (50%, n = 10) of the participants said that they definitely or probably do not have the information necessary to prepare for the health impacts of climate change and 35% (n = 7) were unsure. Almost all (95%, n = 19) of the participants said that they never or seldom receive training or workshops about the health impacts of climate change in their line of duty and 90% (n = 18) of the participants felt that this was not sufficient.

When asked to rate, from a list of 13 options including a free text option, which resources would be most helpful to explore the intersections between climate change and health, or more broadly, health and the environment, participants selected the following five resources in order of importance: Hospital system sustainability quality improvement projects (i.e., initiatives designed to improve the long term feasibility and quality of in-hospital healthcare services), Climate change advocacy (i.e., efforts to raise the awareness of climate change), Accredited short courses, An elective course, and Events (e.g., expert panels, film screenings). A summary of the participants’ perceived preparedness to respond to the health impacts of climate change is provided in Table 4 below.

Table 2: Emergency medicine registrars' and physicians' perceived preparedness to respond to the health impacts of climate change.

<i>Questions and Responses</i>	<i>Frequency</i>	<i>Percentage</i>
If a patient asked you, "How can climate change impact my health?", how prepared would you feel to engage in a conversation with them?		
Not at all prepared	4	20%
Very little prepared	5	25%
Neither little nor much	8	40%
Quite prepared	2	10%
Very prepared	1	5%
Do you think that you have the information necessary to prepare for the health impacts of climate change (e.g., infectious disease, extreme weather events)?		
Definitely not	1	5%
Probably not	9	45%
Neutral	7	35%
Probably	3	15%
Definitely yes	0	0
How often do you receive training/workshops with regard to the health impacts of climate change in your line of duty?		
Never	15	75%
Seldom	4	20%
Sometimes	1	5%
Often	0	0
Do you think you have received enough training/workshops in your line of duty with regard to climate change and health issues (e.g., impacts of climate change on infectious diseases)?		
Definitely not	12	60%
Probably not	6	30%
Neutral	0	0
Probably	2	10%
Definitely yes	0	0

Objective 3: Describe perceptions, level of engagement, and expectations related to climate change in medical education and training.

When asked whether the health impacts of climate change should be included in health sciences curricula, 85% (n = 17) of the participants believed that it probably or definitely should be included. The majority (70%, n = 14) of the participants believed it should form part of the mandatory preclinical undergraduate medical curriculum. Other levels chosen by participants were postgraduate medical specialist training (40%, n = 8), mandatory clinical rotation (20%, n = 4), and elective preclinical undergraduate medical curriculum (15%, n = 3).

All the participants said that they did not receive any formal training surrounding the health impacts of climate change during medical school (undergraduate and postgraduate). When asked whether they felt this was sufficient, the majority (70%, n = 14) said probably not or definitely not. Most (95%, n = 19) participants also indicated that their level of engagement regarding climate change during medical school was either low (i.e., they would follow the news to know what is going on related to climate change) or nothing. A summary of participants' perceptions about climate change-related health education in health sciences curricula is provided in Table 5 below.

Table 3. Emergency medicine registrars' and physicians' perceptions about climate change-related health education in health sciences curricula.

<i>Questions and Responses</i>	<i>Frequency</i>	<i>Percentage</i>
<i>Do you believe that the health impacts of climate change should be included in health sciences curricula?</i>		
Definitely not	0	0
Probably not	1	5%
Neutral	2	10%
Probably	10	50%
Definitely yes	7	35%
<i>At what levels do you think curriculum on climate change should be included in medical training?</i>		
Mandatory preclinical undergraduate medical curriculum	14	70%
Postgraduate medical specialist training	8	40%
Mandatory clinical rotation	4	20%
Elective preclinical undergraduate medical curriculum	3	15%
Elective clinical rotation	2	10%
None of the above	1	5%
Postgraduate course	1	5%

Table 5 Continued

<i>Questions and Responses</i>	<i>Frequency</i>	<i>Percentage</i>
<i>Did you receive formal training surrounding the health impacts of climate change during medical school?</i>		
No	20	100%
Yes	0	0
<i>Do you think that you received enough formal training surrounding the health impacts of climate change?</i>		
Definitely not	7	35%
Probably not	7	35%
Neutral	5	25%
Probably	1	5%
Definitely yes	0	0
<i>How would you rate your level of engagement related to climate change during medical school?</i>		
Very high	0	0
High	0	0
Moderate	1	5%
Low	15	75%
None	4	20%

When asked to provide additional comments related to climate change education at their medical school, only 9 participants responded to the question and results were therefore not quantified. Some participants described climate change as “a public health threat and priority” (Participant 11, woman, 8 years working in ED) that “should be discussed and debated (e)specially at postgraduate/registrar level” (Participant 9, woman, 7 years working in ED). One participant said: “Unless we start raising a generation of socially responsible professionals, we are doomed” (Participant 19, woman, 26 years’ experience in the ED). Others highlighted the importance of including information about the regional effects of climate change, public health aspects, social determinants of health, and how the political landscape impacts access to food and water. However, not everyone expressed a need for the integration of climate change in medical education and training. One participant wrote that while “climate change is a major challenge.. requiring mass cooperation and coordination...I do not find it pertinent to physicians in particular beyond being aware of

the changes and how they impact our patients in reality (not how they might in future etc.)" (Participant 16, man, 3 years working in ED).

Objective 4: Describe the perceived priorities to focus on that are expected to increase preparedness to respond to the health impacts of climate change.

Participants were asked what in their opinion are the main priorities to focus on that will increase preparedness to respond to the health impacts of climate change. All 20 participants responded to this free-text question. The majority (65%, n = 13) of the participants emphasised the importance of *"Education and information!"* (Participant 18, woman, 6 years working in ED). Participants highlighted a need for *"increased awareness of climate change impact, prevention and preparation strategies"* (Participant 1, woman, 5 years working in ED), *"knowledge on (the) effects of climate change on health"* (Participant 3, woman, 8 years working in ED) and *"an awareness of epidemiological patterns of disease."* (Participant 16, man, 3 years working in ED). Other priorities included the identification of a network of experts *"..to effectively bring climate advocacy into undergraduate medicine"* (Participant 19, woman, 26 years working in ED), a focus on the health impacts of climate change (e.g., infectious disease and food insecurity) as well as social determinants of health (e.g., poverty), and the availability of resources and *"policies to deal with disaster management"* (Participant 8, woman, 7 years working in ED).

Exploratory analysis

Mann-Whitney U tests were run to determine if there were differences between participants who identified as women and those who identified as men concerning their perceptions about the health impacts of climate change, climate change in medical education and training, and self-perceived preparedness. Distributions of the perception scores for those participants who identified as men and women were not similar, as assessed by visual inspection. Results indicated that perceptions of the extent to which participants agreed with the statement about whether climate change will affect their personal health scores for those who identified as women (mean rank = 12.65) were statistically significantly higher than for participants who identified as men (mean rank = 6.50), $U = 17.5$, $z = -2.323$, $p = .024$. No other significant differences were found between these two groups. A summary of distribution scores per gender for perceptions about the impact of climate change on personal health is reported in Table 6 below.

Table 4. Frequency and percentage of emergency medicine registrars' and physicians' perceptions about climate change's impact on their personal health by self-identified gender

Question	Response	As what gender do you identify?	
		Women	Men
		Frequency (Percentage)	
	Strongly disagree	0	1 (5%)
Climate change	Disagree	1 (5%)	1 (5%)
will affect my	Unsure	0	3 (15%)
personal health.	Agree	6 (30%)	1 (5%)
	Strongly agree	6 (30%)	1 (5%)

Mann-Whitney U tests were run to determine if there were differences between participants who have graduated with an MMed degree and those who are still studying with regards to their perceptions about the health impacts of climate change, climate change in medical education and training, and self-perceived preparedness. Distributions of the perception scores for both groups were not similar, as assessed by visual inspection. Results indicated that those who have not yet graduated with an MMed degree (Mean rank = 8.67) scored statistically significantly lower on whether they believe they have the information necessary to prepare for the health impacts of climate change than those who have graduated (Mean rank = 16.00), $U = 10.00$, $z = -2.581$, $p = .015$. No other statistically significant differences were found.

Chapter 6: Discussion

Climate change is seen as the “biggest global health threat of the 21st century” ⁽¹⁾ and has several direct and indirect impacts on health. ⁽¹⁻⁵⁾ These impacts occur on top of existing conditions, which places a disproportionate burden on those who are already vulnerable. ⁽⁶⁾ Seeing that emergency healthcare often serves as the safety net for healthcare and the first point of contact for patients whose health has been adversely impacted by climate change, it is crucial that emergency medicine specialists understand these impacts and are appropriately educated and prepared to effectively respond to them in practice. However, it is expected that many emergency medicine specialists are not well versed on the health impacts of climate change, making it essential to assess their current perception of and preparedness to address these impacts in clinical practice. Therefore, this study aimed to describe emergency medicine registrars’ and physicians’ perceptions of climate change and health, climate-related health education, and self-perceived preparedness to respond to these impacts.

In this final chapter, the research results are discussed with regard to the four objectives that framed the focus of the study. Suggestions for future research are also considered and the limitations and contribution of the present study are discussed.

The majority of the emergency medicine registrars and physicians participating in this study agreed or strongly agreed that climate change is currently impacting population health and that it will affect their health and that of their future patients. This is in line with other studies across the globe that indicate that healthcare professionals (HCPs) believe that climate change has or will harm human health. ^(9,11,17,63,67,70,83) Furthermore, similar to the results found in this study, HCPs in other studies are concerned for their own health and the health of their patients. ^(7,9,11) In a survey study involving 600 medical students from 12 medical schools across the US, 93.9% of the sample agreed that climate change is currently impacting population health, 94.5% agreed that it will affect the health of their future patients, and 90.8% agreed that climate change will affect their own health. ⁽⁹⁾ It can therefore be said that HCPs recognise the link between climate change and health.

Emergency medicine registrars and physicians in this study however indicated that they feel inadequately prepared to address climate change and health in clinical practice. Results indicated that only 15% of the sample felt prepared to discuss the health impacts of climate change with their patients and 50% indicated that they do not have the information necessary to prepare for these changes. These results are in line with a multi-national survey conducted amongst a sample of 3977 HCPs from 12 health professional associations globally, including the Canadian Medical Association, the Indian Academy of Pediatrics, and the South African Medical Association, which indicated that, while participants are concerned about the health impacts of climate change, they believe that they do not have adequate knowledge on the topic to respond to these impacts. ⁽¹¹⁾

More than two-thirds of the emergency medicine registrars and physicians in this study believed that the training they had received was insufficient to prepare them for their current or future work as emergency specialists caring for patients in a changing climate. This is in line with a recent study conducted in Germany, involving physicians, in which only 4.71% of the sample believed that the medical training they had received so far had sufficiently prepared them to address climate change and health and climate change mitigation in their future work as physicians. ⁽¹⁰⁾

Several studies have echoed this gap in education leading to a lack of preparedness to respond to the health impacts of climate change. ^(17,70) In a survey study, conducted amongst 377 HCPs in Ethiopia, participants expressed a need for additional training on disaster preparedness and response. ⁽⁶⁹⁾ Similar results were obtained from studies conducted in Tanzania, ⁽⁸⁴⁾ Ghana, ⁽⁸⁵⁾ and Uganda. ⁽⁸⁶⁾ It can therefore be argued that there is a gap in medical education and training that results in HCPs, and emergency medicine specialists, feeling inadequately prepared to address climate change and health in clinical practice. This gap in medical education is not surprising as the nexus between climate change and health is an emerging field. As the prominence of climate change in Popular Media and its relevance to health seems to be gaining in popularity, so is scientific literature on the topic. As such, studies like the current study provide an essential departure point for bringing these fields together.

In recent years there has been a notable increase in scientific literature about climate change and health and healthcare facilities. ⁽²³⁾ However, despite an increase in information on the topic, a review of the literature from 2012 to 2022, describing hospital emergency and disaster preparedness in sub-Saharan Africa (SSA), shows that there is still an overall gap in knowledge and skills amongst HCPs about how to prepare for and respond to these impacts. ⁽⁸⁷⁾ Considering that HCPs recognise the link between climate change and health and report feeling inadequately prepared to address these impacts in clinical practice, it is then not surprising that there is a strong call from medical students and educators across the globe for training and education on the topic. ^(11,17–21,63,70,83,88,89)

Despite the call for education and training on the topic, the integration of climate-related health education into medical curricula seems to be low. Emergency medicine registrars and physicians in this study indicated that they did not receive any formal education or training surrounding the health impacts of climate change during medical school. This is in line with other studies showing low to no integration of aspects of climate change and health in medical curricula. ^(12,15,16) In a large multi-national survey study, conducted between 2019 and 2020, in which medical students were asked to report on the current inclusion of climate change and health in their medical curriculum, findings indicated insufficient integration of climate change and health concepts. ⁽¹²⁾ Furthermore, the authors report a “clear inconsistency between environmental changes, community health needs, and medical education”. ^(12, p.1109) Other concerns highlighted by medical students in South Africa include insufficient exposure and education

related to traditional medicine⁽⁹⁰⁾ and social accountability, with an emphasis on local language and cultural learning for improved communication in a clinical context.⁽⁹¹⁾

This gap in medical education results in HCPs that are not adequately prepared to discuss pressing health concerns and address the health needs of the communities they serve,⁽¹²⁾ and highlights the need for the redesign of medical curricula to include context-specific and relevant education to prepare emergency medicine specialists to recognise and respond to the health impacts of climate change that are likely to occur in their contexts.^(12,20)

Emergency medicine registrars and physicians in this study and medical students in a survey study conducted across the US believed that climate change and health should be introduced into medical curricula as mandatory preclinical undergraduate training.⁽⁹⁾ While some authors have indicated the importance of considering barriers to including climate-related health education in medical curricula, such as an already crowded curriculum and the burden of work^(11,63,67) others see the integration as an opportunity to strengthen and expand understandings of the interplay between people and the environment and how this affects health.⁽²¹⁾

Constitutionally, in South Africa, the provision of emergency healthcare is a basic human right.⁽⁹²⁾ Situating emergency medicine specialists at the forefront of the response to the health impacts of climate change, which disproportionately affects those who are already vulnerable, then raises the question of whether an education gap, that arguably results in an emergency workforce that is inadequately prepared to sufficiently address the health impacts of climate change, is a climate justice concern that cannot be ignored.

Climate justice is essential in the discussion about actions to address the impacts of climate change on communities in Africa⁽⁹³⁾ as it takes into consideration the impacts of climate change through a human rights lens, recognising the intersecting vulnerabilities and the disproportionate impact of climate change on marginalised communities.^(93,94) The impacts of climate change (such as health emergencies caused by extreme weather events or changes in disease patterns), occur on top of already existing social inequalities,⁽⁴²⁾ and have been found to intensify poverty, especially in low-income populations, such as those found in Africa.⁽⁵⁵⁾ South Africa, which has recently been declared the most unequal country in the world⁽⁵¹⁾ is no exception to this.

A recent review of the literature indicated that climate change is increasing intersecting vulnerabilities and multi-dimensional inequalities amongst vulnerable populations in South Africa.⁽⁵⁸⁾ The COVID-19 pandemic is an example of how a health emergency can amplify health inequality that already exists in society,^(56,95) by creating a vicious cycle in which vulnerable populations experience greater exposure to risks and damages that leave them less able to cope and recover from future impacts.⁽⁶⁾ In South Africa, the COVID-19 pandemic exacerbated the health outcomes for the poor relative to the well-off through factors such as

race, income, and hunger. ⁽⁹⁶⁾ This was evident in a study conducted in Cape Town, showing higher mortality rates in low-income communities, ⁽⁹⁷⁾ which seems to also be the case in lower socio-economic communities compared to affluent communities, globally. ⁽⁹⁸⁾

Pillai et al. suggest that *"as medical schools commit to training students to recognise injustice and promote health equity, ..these goals cannot be met without greater emphasis on environmental health - including climate science - in the curriculum."* ^(19, p.1501) It can be reasonably assumed that an increase in understanding of the topic will not only prepare emergency medicine specialists for clinical work but could also result in greater involvement in the implementation of climate change mitigative and adaptive strategies and encourage a group of trusted and influential voices in the community to advocate for climate change. However, a lack of education and preparedness to effectively respond to these health impacts could have the opposite effect: it could exacerbate the impact of climate change on those populations who are already experiencing intersecting vulnerabilities and worsen inequality in South Africa. It is therefore imperative that emergency medicine specialists receive appropriate education and training to enable them to effectively care for those communities who will be most affected by climate change.

While this was not the focus of the study, exploratory analysis revealed an interesting difference between those participants who identified as women and those who identified as men. Findings in this study showed a gender difference with regard to concern about personal health. The extent to which participants agreed with the statement that climate change will affect their personal health scores were statistically significantly higher for women than for men. In this study, 92% of the sample who identified as women agreed or strongly agreed that climate change will affect their personal health whereas only 29% of the participants who identified as men agreed or strongly agreed with this statement.

Several studies have shown that women are significantly more concerned about the health impacts of climate change and they express a stronger need for more information on the topic. ^(10,64,68,72) A self-administered survey study, involving medical students across China, showed that women were significantly more likely than men to perceive climate change and its health impacts as a "bad thing" ($\chi^2 = 32.87$ vs $\chi^2 = 26.02$, $p < 0.01$). ⁽⁶⁸⁾ Similarly, in a study involving primary care physicians in the US, women compared to men were more often "somewhat" or "very concerned" about climate change (92.7% vs 72.9%, $p = 0.004$), more often indicated that climate change would harm people in the US "a moderate amount" or "a great deal" (89.1% vs 70.2%, $p = 0.028$), and more often indicated that they would personally be harmed "a moderate amount" or "a great deal" (68.6% vs 44.5%, $p = 0.002$). ⁽⁶⁴⁾ In another study, involving medical students in Germany, gender formed part of a model that explained 45.9% of the variance of learning needs related to climate change in medical curricula, $F(7, 132) = 17.86$, $p < 0.001$. ⁽¹⁰⁾ Specifically, women, in a higher semester, and with stronger role perception expressed a stronger desire for climate change and health topics to be integrated into the medical curriculum. ⁽¹⁰⁾ Finally, female FHS students at the University

of Cape Town, South Africa, were significantly more inclined to follow a sustainable lifestyle than their male counterparts (43.2% vs 13.6%, $p = 0.003$),⁽⁷²⁾ which could be a result of a higher concern with the issue.

Evidence suggests that these gender differences also exist in other sectors. A study involving economists indicated that women economists expressed more concern over social and environmental impacts (90.1% vs 83.4%, $p < 0.1$) and greater support for governmental interventions to address these impacts than their male counterparts (84.7% vs 76.6%, $p < 0.1$).⁽⁹⁹⁾ Similarly, female members of the European Parliament, despite expressing similar levels of concern for the environment than their male counterparts, were significantly more likely to support environmental legislation ($\beta = -0.12$ vs $\beta = -0.14$, $p < 0.01$).⁽¹⁰⁰⁾ This was also found in the American public where women had higher levels of climate change concern ($\bar{x} = 1.55$ vs $\bar{x} = 1.29$, $p < 0.01$) and ($\bar{x} = 1.91$ vs $\bar{x} = 1.73$, $p < 0.01$) knowledge than men, however, they were more likely to underestimate the knowledge they had ($\bar{x} = 2.75$ vs $\bar{x} = 3.04$, $p < 0.01$).⁽¹⁰¹⁾

Interestingly, in a series of seven studies involving university students, the public, and consumers, Brough et al. found evidence to suggest that, due to an implicit cognitive association between femininity and pro-environmental behaviour (PEB), those who engage in PEB are perceived as more feminine and also perceive themselves as more feminine.⁽¹⁰²⁾ The tendency for women to be more concerned about climate change and more inclined to adopt PEBs could therefore be partially explained by gender identity maintenance (i.e., conforming to gender expectations), which conversely threatens the gender identity of men (who are expected to not be feminine).⁽¹⁰²⁾ While this could be a possible explanation for the gender difference found in this study, more research would be needed to explore this gender difference. Also, it should be noted that gender in this study was not collected as a binary construct, but rather participants were asked to choose the gender they mostly identify as. Options included man, woman, and non-binary, and participants were given a free-text option to self-describe. It is not clear whether gender was collected as a binary construct in the studies discussed above, and therefore, any gender-specific inferences should be considered with caution.

This study shows that emergency medicine registrars and physicians in South Africa recognise the health impacts of climate change but report feeling inadequately prepared to respond to them in practice. Participants believe that the training and education that they received were not sufficient to care for patients in a changing climate. There was a strong call in the study for the inclusion of climate change in the medical curriculum to better prepare emergency medical specialists for their current and future roles on the frontline of the response to the health impacts of climate change. The inclusion of climate-related health education medical curricula could prepare a group of emergency medicine specialists to better care for the communities they serve.

Conclusion

There was a strong call from emergency medicine registrars and physicians for more education and information on the health impacts of climate change that emerged from the current study, suggesting the potential to expand this research. Integration of climate-related health education and training in medical curricula could enhance climate change preparedness in Emergency Departments across South Africa to respond to these impacts and motivate a group of trusted voices in the community to advocate for better climate change mitigative and adaptive strategies. Climate change education and training are essential for emergency medicine specialists as they are directly impacted by changing disease patterns and extreme weather events and can be potential advocates for climate change.

However, the views expressed in this survey are based on a small sample of emergency care registrars and physicians and additional research should expand the sample to include other cadres of emergency healthcare professionals.

Limitations and strengths

A convenience method of sampling was used to recruit participants for the study. Convenience sampling is susceptible to bias and for that reason, the results of the study are not generalisable to the wider population. While efforts were made to encourage participation by making the survey available for three months and re-circulating the invitation several times during this period, the response rate was low. While it is not possible to calculate the response rate for this study due to the sampling technique that was used, I was able to estimate a response rate of approximately 10% based on the estimated population size of 200. This is similar to other survey studies conducted in the field ranging between 10 – 23%.^(9,11,64,72) In a multi-national survey study, aimed at examining HCPs' views of climate change as a health concern, the response rate varied from 0.4% to 22.5%, with the response rate in South Africa being 3.2%.⁽¹¹⁾ In another survey study exploring FHS students at the University of Cape Town's perceptions of climate change and environmental sustainability, the response rate was 12.5%.⁽⁷²⁾ The response rate in this study therefore seems to be in line with what was obtained in other similar studies.

To get an understanding of the extent of the bias, we compared the sample demographics to the population demographics. A retrospective review of the Health Professions Council of South Africa's (HPCSA) database reported that there were 134 emergency medicine specialists registered (presumably in 2019) of which 83 (62%) were male and 51 (38%) were female.⁽¹⁰³⁾ What this means is that the current sample was likely biased towards the female gender. This is not surprising, considering the explanation of gender differences as they relate to climate change and health contained in the discussion above. Future research should attempt to obtain a sample that is representative of the entire population.

Furthermore, due to self-selection, non-response bias can be expected. For instance, those who have an interest in climate change may have been more likely to participate in the study. This could have led to an overestimation in the sample of the health impacts of climate change, the need to include the topic in medical curricula, and perceived preparedness to deal with it when compared to the rest of the study population. However, as outlined in the discussion, the findings from this study resonate well with the findings from other studies across the globe.

To our knowledge, this is the first study exploring emergency medicine registrars' and physicians' perceptions and preparedness as it relates to the health impacts of climate change and climate change in medical education. Results from this study could therefore be used to inform further research aimed at preparing emergency healthcare in South Africa to respond to the expected climate-related health impacts.

Contribution of the study

This study provided a first look at emergency medicine registrars' and physicians' perceptions of climate change and health, climate-related health education, and self-perceived preparedness to respond to these impacts. It suggested that medical curricula should be redesigned to integrate climate-related health education to better prepare this group of healthcare workers to respond to the health impacts of climate change. This study could have also created awareness amongst emergency medicine registrars and physicians about the relationship between climate change and health.

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Appendix A: Invitation

Social networking platform invitation

Are you an #emergencymedicine #registrar or #physician working in #SouthAfrica? You are invited to participate in a #survey that seeks to understand the #perceptions, #preparedness & training needs of emergency healthcare workers to respond to the #healthimpacts of #climatechange. If you are interested to participate in this study, please follow this link to the survey.

OR

Are you an #emergencymedicine #registrar or #physician working in #SouthAfrica? You are invited to participate in a #survey that seeks to understand your #perceptions #climatechange & #health. Please follow this link to participate: this link

Whatsapp invitation

Are you an emergency medicine registrar or physician working in South Africa? You are invited to participate in a survey that seeks to understand the perceptions, preparedness & training needs of emergency healthcare workers to respond to the health impacts of climate change. If you are interested to participate in this study, please follow this link to the survey.

Email invitation

INVITATION TO TAKE PART IN RESEARCH STUDY: CLIMATE CHANGE AND HEALTH

Dear Prospective Participant,

You are invited to participate in a study that seeks to understand emergency medicine registrars' and physicians' perceptions and self-perceived preparedness to respond to climate-related health impacts. An understanding of this could help create a sense of the education and training needs of emergency healthcare workers that in turn can enhance preparedness for climate-related health concerns and emergencies - thereby reducing risk in vulnerable populations.

We are inviting all emergency medicine registrars and physicians who are registered with the Health Profession Council of South Africa (HPCSA) and working in South Africa to take part in the study. The study was approved by the University of Cape Town's Human Research Ethics Committee (HREC Ref. 065/2023). Participation in the study involves the completion of an online questionnaire which should take approximately 15 to 20 minutes to complete and is completely anonymous.

For more information on the study, ethical clearance, consent, and participation, please click on this link.

Kind Regards,

Elzarie Theron

Appendix B: Questionnaire

Biographical information

- 1.Q In what year did you graduate from medical school? (drop down list)
- 2.Q What medical school did you attend? (open ended)
- 3.Q In what year did or do you expect to graduate as an emergency physician? (drop down list)
- 4.Q At which medical school did you complete or are you currently enrolled for your MMed? (open ended)
- 5.Q For how many years have you been working in the health sector? (open ended)
- 6.Q For how many years have you been working in the emergency department? (open ended)
- 7.Q In which province do you currently work?
- 8.Q In what year were you born? (drop down list)
- 9.Q As what gender do you identify? (man, woman, non-binary, prefer to self-describe (below))

Climate change refers to a long-term change in the Earth's average temperature and weather patterns. Whilst these shifts may be natural, certain human activities are causing these changes to accelerate resulting in human-induced climate change. Human-induced climate change have led to changes in natural systems, such as changes in precipitation patterns, acidification of oceans, melting of glaciers, and changes in the behaviour and ecology of species and ecosystems. In turn, these changes are causing sea levels to rise, changes in the distribution of vector borne diseases and pathogens, and an increase in the frequency and intensity of extreme weather events, such as floods, droughts, and heatwaves.

Perceptions regarding climate change's health impacts:

- 1.Q Do you think there is a link between climate change and health? (Likert-type scale from 1 (definitely not) to 5 (definitely yes) with 3 being neutral)
- 2.Q Please rate the extent to which you agree/disagree with the following statements: (Likert-type scale from 1 (strongly disagree) to 5 (strongly agree) with 3 being unsure)
 - a. Climate change currently impacts population health outcomes.
 - b. Climate change will affect the health of my future patients.
 - c. Climate change will affect my personal health.
 - d. Emergency care providers should know about climate change and its health impacts for clinical practice.

3.A. In your opinion, what are the three top climate change impacts of concern in your province?

- a. Tropical cyclones
- b. Air pollution
- c. Extreme heat
- d. Changes in geographic spread of vector borne diseases
- e. Flooding
- f. Increased severity of droughts
- g. Increased fire risks
- h. Rising sea levels
- i. More severe storms
- j. Not enough food
- k. Other (open ended)

3.B In what way do you think these climate change impacts could influence health? (open ended)

Attitudes regarding climate change's place in health professional education:

4.Q Do you believe that the health impacts of climate change should be included in health sciences curricula? (Likert-type scale from 1 (definitely not) to 5 (definitely yes) with 3 being neutral)

5.Q At what levels do you think curriculum on climate change should be included in medical training? (select all that apply)

- a. Mandatory preclinical undergraduate medical curriculum
- b. Elective preclinical undergraduate medical curriculum
- c. Mandatory clinical rotation
- d. Elective clinical rotation
- e. Postgraduate medical specialist training
- f. Other (open ended)
- g. None of the above

6.Q Did you receive formal training surrounding the health impacts of climate change during medical school? (Binary: yes/no)

- 6.Q.b If yes: At what level did you first receive training surrounding the health impacts of climate change?
- Mandatory preclinical undergraduate medical curriculum
 - Elective preclinical undergraduate medical curriculum
 - Mandatory clinical rotation
 - Elective clinical rotation
 - Postgraduate medical specialist training
 - Other (open ended)
- 7.Q Do you think that you received enough formal training surrounding the health impacts of climate change? (Likert-type scale from 1 (definitely not) to 5 (definitely yes) with 3 being neutral)
- 8.Q How would you rate your level of engagement related to climate change during medical school?
- Very high (i.e., pursuing a research project related to climate change, lead a student interest group)
 - High (i.e., attend an elective related to climate change, member of an interest group)
 - Moderate (i.e., attend climate change related events on campus occasionally)
 - Low (i.e., follow what is going on related to climate change in the news)
 - None
- 9.Q Are there any other thoughts you'd like to share with us regarding climate change education at your medical school? (e.g., which aspects about climate change should be prioritised in medical education and training, if any) (open ended)
- Preparedness to respond to the health impacts of climate change:**
- 10.Q If a patient asked you, "how can climate change impact my health?", how prepared would you feel to engage in a conversation with them? (Likert-type scale from 1 (not prepared) to 5 (very prepared) where 3 is unsure)
- 11.Q Do you think that you have the information necessary to prepare for the health impacts of climate change (e.g., infectious disease, extreme weather event) ? (Likert-type scale from 1 (definitely not) to 5 (definitely yes) with 3 being neutral)
- 12.Q How often do you receive training/workshop with regards to the health impacts of climate change in your line of duty? (Likert-type scale from 1 (never) to 4 (often) with 2 being seldom and 3 being sometimes)

13.Q Do you think you have received enough training/workshops in your line of duty with regards to climate change and health issues (e.g., impacts of climate change on infectious diseases) (Likert-type scale from 1 (definitely not) to 5 (definitely yes) with 3 being unsure)

14.Q Below is a list of resources that could be helpful to explore the intersections between climate change and health, or more broadly, health and the environment. In your opinion, which of these resources would be most helpful? Please choose a maximum of 5 resources and order them in order of preference (1 being most useful to 5 least useful).

- a. Research opportunities
- b. Climate change advocacy
- c. Hospital system sustainability quality improvement projects
- d. Faculty mentorship
- e. An interdisciplinary centre for climate change and health
- f. An elective course
- g. Events (e.g., expert panels, film screenings)
- h. Planetary health conferences
- i. Volunteer opportunities to help community members affected by climate change
- j. Teaching and training resources
- k. Accredited short courses
- l. Open online courses
- m. Dedicated teaching sessions
- n. Other (open ended)
- o. None of the above

14.Q In your opinion, what are the main priorities to focus on that will increase preparedness to respond to the health impacts of climate change? (open ended)

Appendix C: Information and consent

Thank you for following the link to my online survey!

Name of student: Ms Elzarie Theron

Supervisors:

Dr Willem Stassen (Division of Emergency Medicine, University of Cape Town)

Assoc. Prof Gina Ziervogel (Department of Environmental and Geographical Science, University of Cape Town)

STUDY INFORMATION

SURVEY CONSENT PAGE

You are invited to participate in a research study conducted by Elzarie Theron in partial fulfilment of an MPhil degree in the Department of Environmental and Geographic Science of the University of Cape Town.

You have been invited to take part in the study because you are an emergency medicine registrar or physician who is registered with the Health Professions Council of South Africa (HPCSA) and currently working in South Africa.

This study seeks to understand emergency medicine registrars' and physicians' perceptions and self-perceived preparedness to respond to climate-related health impacts. An understanding of this could help create a sense of the education and training needs of healthcare workers that can in turn enhance preparedness for climate-related health concerns and emergencies, thereby reducing risk in vulnerable populations.

PARTICIPATION

Your participation in this survey is voluntary. You may refuse to take part in the research or exit the survey at any time prior to submitting without penalty.

DESCRIPTION OF THE PROCESS

This is a survey study. What that means is that we will ask you to complete a short questionnaire. It is expected that the survey will take approximately 15 to 20 minutes to complete. Please answer all questions as truthfully as possible. There is no way for us to connect your responses to you.

RISKS OR BENEFITS

There are no direct benefits to you for being part of this study. However, the results that we will obtain may help us to make recommendations for the training and education needs as they relate to the health impacts of climate change. This in turn can help to enhance emergency care preparedness and resilience to climate-related health impacts.

ANONYMITY AND CONFIDENTIALITY

Your survey answers will be stored in a password-protected electronic format that will only be accessible to the research team. We will not collect identifying information such as your name, email address, or IP address. Therefore, your responses will remain anonymous. No one will be able to identify you or your answers, and no one will know whether you participated in the study. If you feel you have not been treated according to the descriptions in this form, or that your rights as a participant in research have not been honoured, or you have any questions, concerns, or complaints that you wish to address to someone other than the investigator, you may contact the University of Cape Town's Human Research Ethics Committee on hrec@uct.ac.za.

ETHICS APPROVAL

This proposal has been reviewed and approved by the University of Cape Town's Human Research Ethics Committee (HREC REF 065/2023). The job of these committees is to make sure that research participants are protected from any research-related harm.

WHO TO CONTACT

For more information about the study, you can contact me, Elzarie Theron, at elzarie.theron@uct.ac.za. For questions on the ethical approval of the study, you may contact the University of Cape Town at hrec@uct.ac.za.