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Research article

Health workers' perspectives regarding climate change and health in Kween District, Mount Elgon, Uganda – A qualitative study

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ABSTRACT

Introduction: In Uganda, climate change poses significant threats to human livelihoods by exacerbating existing health challenges and introducing new health threats. This study focused on the knowledge and perspectives of health workers regarding the intersection of health and climate change, with particular emphasis on malaria, a disease prevalent in the country and notably affected by climate variations, especially in fragile mountainous regions such as Mount Elgon.

Materials and Methods: This study was conducted in the Kween District of Mount Elgon, Uganda. We utilized qualitative approaches, recruiting health service providers from various altitudinal zones using snowball sampling techniques. Health facilities were selected through purposive sampling and 69 health service providers participated. Data collection involved semi-structured interviews that explored health workers' knowledge of climate change and its impacts on health, including malaria.

Results: Health workers perceived an increase in disease occurrences attributed to climate change, affecting their work in terms of load and access to facilities during extreme weather conditions such as heavy rains and heatwaves. Malaria cases were perceived to have increased in the higher altitudes that previously experienced limited case numbers. Despite the difficulties in distinguishing between climate change and climate variability, health workers associated these health-related phenomena with long-term weather alterations.

Conclusions: Health workers perceive that climate change is affecting their work and delivery of health services. By leveraging the knowledge and experience of health workers regarding the relationship between health and climate change, there is an opportunity to enhance the resilience of the health system.

1. Background

Climate change and climate variability have resulted in a profound health crisis that undermines the capacity of societies to maintain healthcare systems and overall wellness [1–4]. Climate change is defined as the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer [5]. Meanwhile climate variability includes deviations of some climate variables from a given mean state at all scales (spatial and temporal) beyond that of individual weather events [5]. Climate change and climate variability impact health system performance through several interconnected factors, including increased temperatures, extreme weather events, altered precipitation patterns, shifting disease vectors, and the emergence of new health threats [6–8]. According to the World Health Organization, climate change is predicted to contribute to an additional 250,000 deaths annually between 2030 and 2050 due to conditions exacerbated by climate change, including heat stress, malaria, diarrhoea, and malnutrition [9]. Current interventions and policies suggest a projected warming of 2.50°C to 2.90°C by the end of this century [10]. This warming, alongside other manifestations such as shifts in precipitation patterns and intensities, leads to increased flooding in some regions and drought in others, ands also influences the occurrence and management of vector-borne diseases. The acceleration of climate change thus calls for

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scientifically informed strategies to ensure that health systems and health service delivery are sustained in such circumstances.

In highland areas of Uganda, the consequences of climate change are pronounced, with temperatures approaching the thermal tolerance limits of many organisms [11−13]. Moreover, human communities in these highland areas have weak health systems that are challenged to withstand climate-related hazards [14,15]. In the Mount Elgon areas of Uganda, our previous studies have indicated weak disease surveillance systems despite health risks presented by the changing climate [16]. Climate change and climate variability have caused shifts in the hotspots of some diseases, including malaria, that are increasing within this part of Uganda [17]. This health threat to human populations requires interventions to ensure resilience of the health sector to the effects of climate change. Health system resilience includes its capacity to foresee, absorb and recover, and adapt to shocks that can be caused by climate change and variability [18]. By this definition, interventions that enhance the capacity of health workers to respond to climate change and related impacts provide opportunities for resilience. Such interventions can include enhancing knowledge and information regarding climate change and health. Unfortunately, such initiatives are limited, especially in remote high-altitude areas. Moreover, scientific studies to inform such efforts are lacking.

Despite the pivotal role of health workers, there is a significant gap in training and awareness of climate change health effects, leaving them underprepared for climate-related challenges [16,19]. This increases vulnerability of health systems to climate change and variability. Such incidences of limited health workers' capacities in terms of climate change-related knowledge and information are pronounced in limited resource settings such as remote mountain areas in sub-Saharan Africa [19]. Investing in climate resilience within the health sector offers substantial long-term economic benefits [20−22]. Notably, it reduces the need for expensive emergency responses and preserves the continuity of health services [20−22]. In Uganda, the government has attempted to address the complex challenges posed by climate change, including the development of a Health Adaptation Plan [23]. These initiatives are vital for incorporating climate change considerations into health sector planning. However, there remains a significant gap in data concerning the understanding and perspectives of health workers on climate change, particularly in remote areas like Mount Elgon [16]. To help fill this gap, this study aimed to assess health workers' knowledge of climate change as well as their coping strategies at the facility level, with the goal of enhancing future strategies and planning for climate resilience in similar health systems. This approach is important, as health workers' perspectives have been associated with the quality of health service delivery [24].

2. Methods

This cross-sectional study used qualitative methods to gather insights into the experiences, thoughts, and insights of health workers on climate change and its impact on health in Uganda [25]. We surveyed health workers in 24 purposively selected health facilities within Kween District of Mount Elgon. These facilities were chosen because they have existed in the district for at least 20 years, thereby experiencing multiple climate-related challenges over time. This selection criterion ensured that the health systems and personnel at these facilities could provide experience-based insights into the interplay between climate change and health systems in this area. The health service providers were selected using snowball sampling techniques.

The questionnaire, developed by the corresponding author and reviewed by the other authors, encompassed various aspects of climate change, including its occurrence, the distinction between climate change and climate variability, and its impacts on health. Additionally, the questionnaire covered aspects including strategies to mitigate these impacts, in alignment with the Sustainable Livelihood Framework, which values local knowledge and engages with community members, and was instrumental in guiding our study [26]. The Sustainable Livelihood Framework supports methodologies such as Rapid Rural Appraisal (RRA) and Participatory Learning and Action (PLA), and draws partly on the Capability Approach, emphasizing the assets crucial for human livelihoods and wellbeing [27]. Given its proven effectiveness in understanding resilience in rural settings, this framework was particularly suitable for our study area. By focusing on health workers from the same district, this approach can offer a comprehensive local perspective on climate change and health.

2.1. Data collection and sampling

Data collection was carried out between July and August 2019 using semi-structured interview questionnaires (Supplementary Material I) developed by the corresponding author (and reviewed by other authors). These questionnaires were pretested with health workers from two facilities to ensure the reliability and validity of the questions [28,29]. During the pretesting, the content validity index was computed, and was within the recommended limits i.e., $\geq$0.75. Following the pretest, the survey was administered to health workers across various altitudinal zones including low, middle, and high altitudes. The survey aimed to include at least one health professional from each health facility, targeting nurses, laboratory technicians, community health workers, and other cadres involved in service delivery.

Respondents were selected using purposive sampling techniques, focusing on individuals who could provide insights into improving the health system's resilience to climate change. In each facility, the head of the facility was interviewed, and when other professionals were available, they were included as well to provide additional data. This approach was particularly useful in smaller health facilities, where staff often have a broad understanding of multiple departments.

Interviews were held with 69 healthcare workers. The interviews were conducted in English, supplemented by Kupsabiny (the local language) when necessary, with the aid of a community-recruited translator. A note taker, also recruited from the local community, recorded responses verbatim to ensure accurate data capture. The corresponding author took additional notes to aid in the analysis of the transcripts. All interviews also were recorded using a Sony ICD-UX570 (Sony ICD-UX570, Sony Corporation, Tokyo, Japan) to further facilitate accurate data capture.

2.2. Data analysis

Data from the survey were analyzed using a thematic approach as outlined by Maguire and Delahunt (2017) [30]. The process involved several key steps. A thorough review of notes taken during discussions and the audio recording transcripts enabled identification of dominant themes that emerged during the discussions.

During the indexing phase, the transcripts were analyzed to apply codes to the responses, thereby segregating interesting quotes from the transcripts, utilizing *NVivo Software version 14* to assist in the organization and retrieval of data. After identifying potential themes that aligned with the study's objectives, we developed a coding frame to guide the mapping and interpretation of the coded data, ensuring that each piece of data was considered within the broader context of the study. We paid close attention to the context, comments, and specific words used by participants to enhance the internal consistency of the data. To further ensure the reliability of our findings, we employed triangulation techniques which involved discussions with some health service leaders to mitigate potential bias and validate the data interpretation.

3. Results

3.1. Sociodemographic characteristics of respondents

Interviews were conducted in 24 health facilities situated across the three altitudinal zones of Mount Elgon, with an equal distribution of

Table 1
Categories of the respondents engaged during the survey.

Altitude	Cadre of the respondent	Number
Lower	Nurses	8
	Laboratory technicians	6
	Community health worker	8
Mid	Doctors	1
	Nurses	8
	Laboratory technicians	8
	Community health worker	8
Higher	Nurses	8
	Laboratory technicians	6
	Community health worker	8

facilities in low, middle, and high altitudes (eight facilities per zone). A total of 69 health workers participated in the study with diverse representation across different healthcare roles. Participants included male and female respondents across the various roles. This sample size was deemed sufficient to reach saturation during the interviews, as indicated in Table 1.

3.2. Perspectives on the occurrence of climate change

Participants from various segments of the health workforce shared observations on the notable shifts in climatic patterns affecting their lives. They reported significant changes such as alterations in rainfall amounts and patterns, prolonged dry seasons, and more severe heatwaves during these periods. These environmental changes were observed to persist for longer durations than in the past, impacting several facets of community livelihoods across critical assets like human, social, financial, physical, and natural resources that are essential for sustaining their way of life.

For human capital (e.g., health), a major concern raised was the increased frequency and spread of diseases. Physical assets were also under threat, with reports of damage to infrastructure such as housing and roads. These responses were consistent across different altitudinal zones, underscoring the widespread impact of these climatic shifts. Representative quotes from the discussions are shown below and in Table 2.

"These days, rainfall patterns are very unpredictable… This affects our food production that we use for buying medicines in the hospital," (older nurse in the middle altitude).

"The drought periods are so unpredictable unlike in the past…" (older community health worker from lower altitude).
"When we were young, these problems of malaria were not there… But these days, we go to the hospital every month especially during wet season to treat malaria," (nurse from higher altitude).
"These days diseases are common and some like malaria are now even being reported in high altitude areas. This means that the mosquitoes are surviving in these areas," (nurse from middle higher altitude).

3.2.1. Views on "climate change" versus "climate variability"

All respondents acknowledged significant changes in climate-related events that have impacted their daily lives and local environments, particularly affecting planting seasons, temperatures, and rainfall patterns. While these changes were perceived as constant over the years they have resided in the area, there was a noted confusion between the concepts of climate change and climate variability. However, respondents generally regarded variability as part of the broader climate change phenomena. This perception remained consistent across different altitudinal zones. Key observations include those noted below.

"I remember our area was a bit cool, but it has become very hot nowadays…" (nurse from high altitude area).

"Rainfall has changed a lot, and this change has remained constant for very many years from my childhood," (nurse from middle altitude).

3.2.2. Climate change and malaria

The study highlighted a significant rise in malaria cases, with the disease expanding into previously unaffected high-altitude areas. This shift has raised concerns about treatment effectiveness, which participants believe could be influenced by climate change. While respondents perceived that malaria is more difficult to treat effectively, it is not clear if this is a result specifically of climate change or might reflect an increased incidence of the disease in areas where providers have less long-term experience.

Table 2
Pathways of climate change impacts on healthcare delivery.

Climate Change Related Event/Hazard	Impact on Health	Quotes/Examples
Heavy Rains	Heavy rains can lead to flooding and restricted movement for both healthcare providers and patients, causing healthcare worker absenteeism and impacting patient adherence to medication regimens.	*"Some rains make roads impassable, and it leads to absenteeism by staff thus consequences on dosage adherence by patients."* – male doctor from higher altitude
Extreme Heat	Extreme heat results in discomfort and can reduce work speed, affecting work efficiency overall.	*"Sometimes it's too hot that you become less active because you need some shade and cool environment."* – female nurse from lower altitude areas
New Diseases/pests in New Areas	Warmer conditions in some regions, especially high altitudes, are leading to the occurrence of diseases previously unreported in those areas. This affects humans, animals, and crops, impacting income and nutrition.	*"There are areas where we never had some diseases like malaria, but they are occurring now… Like in Musop, malaria was not there but these days it's occurring. This is the same thing for crops and animals, some pests and diseases are occurring and yet they were not there, and it affects our incomes as well as health through nutrition."* –doctor from middle altitude areas *"Climate change is creating conditions that are warmer and support growth and development of such pests and pathogens that cause diseases to humans, animals, and crops."* – Another male nurse from middle altitude added
Extreme Wind	Extreme wind, particularly common from December to April, is perceived by workers to increase respiratory illnesses, adding to the workload at health facilities and affecting the health of care workers themselves.	*"We have this too much wind during December – April and there is a way it causes an increase in respiratory infections in our teams and community members. And you know such infections in community increase the workload on our end with more stress on our staff because of more work times."* – male nurse from middle altitude areas

"Malaria occurrences have increased because mosquitoes are now more adapted to high altitude areas..." (laboratory assistant from middle altitude area).

"Malaria has become more difficult to treat nowadays. Sometimes we use available drugs but they fail," (nurse from higher altitude).

3.2.3. Impacts of climate change and variability on health workers

Health workers have observed a significant increase in patient numbers, particularly during rainy seasons, leading to heightened workloads. This surge is attributed primarily to the rising incidence of malaria, along with respiratory and gastrointestinal infections, which are becoming increasingly prevalent due to climate variability and change. These changes are most pronounced in lower altitude areas. Notable comments from the health workers illustrate these challenges:

"The number of patients suffering from malaria have increased..." (nurse from lower altitude).

"Flood events have increased resulting into increased transmission of gastrointestinal infections..." (nurse from middle altitude).

3.3. Impact pathways and health care delivery challenges

The analysis of how climate change impacts health reveals several critical interactions that affect multiple dimensions of health and healthcare delivery (specific quotes shown in Table 2). Heavy rains were frequently mentioned as significant disruptors, leading to floods and limiting mobility for healthcare providers and patients alike. This reduced access to healthcare services results in increased absenteeism among healthcare workers and subsequent challenges in medication adherence for patients. Extreme heat also poses substantial challenges, affecting the physical comfort and productivity of healthcare staff. Furthermore, the increased intensity and emergence of new diseases in areas previously unaffected, particularly at higher altitudes, reflect another significant impact of climate change. This shift affects not only human health but also extends to animals and crops, impacting economic stability and nutritional health. Lastly, the prevalence of extreme wind, especially from December to April, has been associated with an uptick in respiratory illnesses, which burdens healthcare facilities and affects the health of the workers themselves. The association between wind and respiratory infection in this region remains incompletely studied but is a perception among health workers.

3.4. Potential interventions to manage the challenge

Respondents suggested a variety of interventions across different capital assets to mitigate the impacts of climate change. These suggestions included training on climate change, increasing human resources, improving physical infrastructure such as intensive care units and isolation wards, and enhancing social networks to facilitate better information flow. These responses were consistent across the altitudinal zones. One doctor from the middle altitude emphasized the need for climate education, stating, *"First, we need training on this thing called climate change... We also need to limit emission of greenhouse gases."*

A nurse highlighted the dual challenge of climate change, noting, "Climate change first increases the number of cases but also the number of those with new highly pathogenic infections."

4. Discussion

The findings from this study contribute to the ongoing dialogue concerning the implications of climate change on health systems, specifically through the perspective of health workers in Uganda. These insights corroborate the broader patterns of highly variable malaria occurrences identified in our previous study [17], and also provide a nuanced understanding of the perceived localized impacts of climate change. Our results underscore the perception among health workers that climate change is adversely affecting human health and health systems, echoing findings from similar settings. For instance, studies conducted in other parts of Uganda and across sub-Saharan Africa indicate analogous changes in rainfall patterns and rising temperatures, which correlate with increased malaria incidence [31,32]. This alignment not only validates our findings but also enriches our understanding by situating them within a broader regional and climatic context. Additionally, comparative analyses, such as those by Ellwanger et al. and Nissan et al. [33,34] illustrate how heightened preventive measures in certain regions have mitigated these impacts. This contrast underscores the pivotal role of adaptive strategies in healthcare planning and disease management, highlighting the importance of tailored interventions that respond to specific local challenges posed by climate variability exacerbated by climate change.

Our study highlights a less frequently addressed impact of climate change on healthcare delivery, specifically the mental health strains and increased workload on health workers during extreme weather events. These findings expand our understanding of climate change impacts to include not only direct physical health and infrastructural damages but also the psychological and operational challenges healthcare providers face. Such insights emphasize the importance of a comprehensive approach to health system strengthening. This approach should focus not only on enhancing infrastructure and disease prevention but also on improving the well-being and operational capacity of healthcare workers. Addressing both aspects is vital for building resilience in health systems, enabling them to manage the increased patient influx and complex health emergencies associated with climate variability effectively [35,36].

The unpredictability of climate related events, as highlighted in our findings, presents significant challenges to health planning and resource allocation in rural settings. These challenges underscore the necessity for developing robust predictive models that can accurately forecast climate-related events, thereby enhancing preparedness and strategic resource allocation [37–39]. There is a clear need for more adaptable health system planning that can respond swiftly to rapidly changing conditions without compromising the quality of healthcare delivery [40,41]. Potential adaptive strategies could include deploying mobile health units, stockpiling essential medical supplies, and training community health workers to efficiently manage disease surges. These measures would bolster the resilience of health systems and ensure the continuous accessibility and effectiveness of healthcare services amidst the escalating uncertainties of climate change [42].

Employing the Sustainable Livelihood Framework provides a structured method for examining the impacts of climate change on various forms of capital - human, social, financial, physical, and natural. This approach facilitates a holistic analysis of these impacts and suggests integrative strategies for enhancing resilience within health systems [43]. For instance, by enhancing human capital through targeted education and training, community health outcomes can be improved. Strengthening social capital through community-led health initiatives can sustain healthcare delivery during crises. Protecting financial capital with supportive systems and insurance can mitigate climate-related economic shocks. Additionally, bolstering physical capital with robust health infrastructure ensures continuous access to healthcare services.

Our findings align closely with global health policies, particularly the World Health Organisation's 2020 roadmap for integrating health and climate change [44]. This alignment underscores the importance of incorporating local experiences into broader policy frameworks to ensure that the strategies developed are not only informed by global directives but also finely attuned to the specific needs and conditions of local communities, thereby enhancing the effectiveness and sustainability of these measures. This study helps to inform interventions that aim at addressing the immediate impacts of climate change comprehensively and sets the stage for systemic changes needed to strengthen health systems against future climatic challenges.

4.1. Limitations

While this study provides a unique exploration of the perspectives of health workers on the impacts of climate change in some of Uganda's most challenging areas to access, the study also has limitations. It relies exclusively on qualitative data, which provides depth but lacks the broader generalizability and statistical grounding of quantitative analyses. The focus on remote rural areas, while critical, may not fully represent conditions in urban settings or regions with different health infrastructures and climatic impacts. Additionally, the data may reflect inherent biases linked to the personal and professional experiences and knowledge of the health workers, potentially influencing the study's outcomes and interpretations.

5. Conclusions

This study advances our understanding of the impacts of climate change on health systems in rural Uganda, revealing profound challenges faced by health workers. Participants have identified key issues, including altered climatic conditions that lead to shifts in patterns of diseases such as malaria, and that increase operational and mental health strains on healthcare providers. Applying the Sustainable Livelihood Framework, this study demonstrates the multifaceted impacts of these changes and underscores the critical need for adaptive strategies in healthcare planning and resource allocation. The insights gained highlight the urgent necessity to integrate considerations of climate change into the strengthening of health systems, especially in vulnerable, hard-to-reach areas. The results also emphasize the need for future research to incorporate quantitative methods to extend the applicability of the findings and enhance their policy relevance. Future efforts should aim to broaden the geographic scope of research and diversify methodologies to capture comprehensively the complex dynamics between climate change and health system operations. Such research is crucial for developing health systems that are both responsive and resilient to the challenges posed by climate change.

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Ethical approval

The study was approved by the Research Ethics Committee of Makerere University College of Veterinary Medicine, Animal Resources and Biosecurity (Reference number SBLS.SA.2018). Written and informed consent was obtained from participants to participate in this study, publish and disseminate the research findings.

Data sharing/availability statement

As survey data contains personal information, it may be ethically incorrect to share it as it is. However, requests can be sent directly to the corresponding author via email: siyaggrey@gmail.com.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Aggrey Siya: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Akim Tafadzwa Lukwa:** Writing – review & editing, Writing – original draft, Visualization, Software, Formal analysis, Data curation, Conceptualization. **Chemutai Faith:** Writing – review & editing, Writing – original draft. **Noah Mutai:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation. **Plaxcedes Chiwire:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

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Supplementary materials

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