Original Article

Vulnerabilities and Adaptive Strategies of People Living with HIV/AIDS to Climate Change-Induced Hazards in Rubavu District, Rwanda

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Abstract

Background
Climate change-induced hazards are a global public health concern. Although various programs have been implemented to support People Living with HIV (PLHIV) in Rwanda, there is limited scientific literature documenting their specific vulnerabilities and adaptive strategies in response to climate change-induced hazards.

Objective
This study explored the vulnerabilities and adaptive strategies of PLHIV to climate change-induced hazards in Rubavu District, Rwanda.

Methods
An exploratory qualitative design was used. Data were collected through seven focus group discussions and eight key informant interviews using prepared interview guides. The collected data were analyzed thematically.

Results
Participants reported that climate change-related hazards exacerbate the vulnerabilities of People Living with HIV (PLHIV), including the loss of personal property, reduced access to antiretroviral therapy (ART), and inadequate nutrition, among others. Participants indicated that household-level, community based and institutional supports were employed as adaptive strategies.

Conclusion
PLHIV are particularly susceptible to climate change-induced hazards. In response, various adaptive strategies have been implemented at multiple levels. This study underscores the importance of strengthening the financial capacity of PLHIV as a key measure to reduce their vulnerability to climate-related hazards.
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Keywords: Vulnerability, Climate change, HIV

Introduction

Climate change is a global environmental and public health challenge that affects humans and the environment.[1] It refers to the long-term alteration of global weather patterns and average temperatures due to human activities, such as burning fossil fuels, deforestation, industrial processes, and other natural activities.[1,2] Climate change can lead to a range of negative impacts, including rising sea levels and more frequent and severe weather events such as heat waves, droughts, and floods.[3, 4] The literature reports that those impacts resulting from climate change hazards are expected to intensify in the coming decades due to inadequate adaptation mechanisms, lack of knowledge, outdated adaptation technologies, and limited financial resources, among other factors.[5]

It is reported that climate change poses adverse effects to humans in different ways, and the degree of vulnerability varies significantly. Scholars show that climate change-induced hazards affect health by disrupting food systems,[6] increasing food insecurity, water scarcity, vector-borne illnesses, and mental health problems.[6–8] A shift in temperature and precipitations trigger the longevity of some vectors, resulting in the burden of some infectious diseases and flooding, respectively. Such climate disasters affect human health and cause significant infrastructure damage, such as wastewater treatment plants and road networks, resulting in significant economic losses.[9] The World Economic Forum (WEF) reports that extreme weather, climate, and water-related events caused nearly $1.5 trillion in economic losses over the decade to 2019.[10] Scholars report that adverse effects on human health are influenced by factors such as life stages, adaptive abilities and existing health conditions such as living with HIV, cardiovascular disease, and respiratory disorder, among others.[11]

People living with HIV (PLHIV) are particularly vulnerable to climate change-induced hazards due to a combination of health-related, social, economic, and environmental factors. Evidence suggests that the increased incidence of diseases such as malaria and respiratory infections among PLHIV is linked to their compromised immune systems, which, in some cases, can result in fatal outcomes.[12, 13] Climate change may further exacerbate their vulnerability by increasing the prevalence of diseases such as malaria, respiratory infections, and other opportunistic infections, which tend to be more severe in individuals with weakened immune systems.[13] It was noted that regular access to antiretroviral therapy (ART) is a fundamental element for managing HIV.[14] However, a study done in South Africa indicated irregular adherence to HIV, related services due to road blockage of landslides and flooding, which mostly interrupted regular access to healthcare services, including Antiretroviral (ARV) drugs, Voluntary Counseling and testing (VCT) and Prevention of Mother to Child Transmission. [15]

It is reported in the literature that the impacts of climate change hazards have negative impacts on PLHIV health in various ways. It has been shown that climate change hazards, such as floods and hurricanes, may destroy or damage health facilities and disrupt access to health services, including antiretroviral therapy and support services. [16,17] In addition, stress and displacement can lead to missed doses, increasing the risk of drug resistance and disease progression. In addition, climate change increases the spread of vector-borne diseases such as malaria and dengue and water-associated diseases (such as cholera and diarrhoea), which are more severe in PLHIV because of their weaker immune system.[18] This is combined with nutritional and food insecurity, which could also be associated with climate change.[17]

The vulnerability of PLHIV is worsened in low and middle-income countries due to weak healthcare infrastructures, inadequate health professionals, food insecurity, economic and political instability, and inadequate water and sanitation services, among other factors. [14,19] The World Bank predicts that the consequences of severe weather events will result in at least an additional 21 million

deaths in 2050, mainly attributed to malnutrition, malaria, and diarrheal diseases.[20] The vulnerable groups, like PLHIV, will be more affected compared to other populations.[20] According to UNAIDS, an estimated 39.9 million people were living with HIV in 2023, and approximately 630,000 deaths were attributed to HIV/AIDS-related illnesses.[21] In Rwanda, the prevalence of HIV among adults is 3%. Impressively, 95% of individuals who have tested positive for HIV are currently receiving treatment.[22] Given climate change's expected adverse health effects, PLHIV must also be prioritized in climate adaptation and response strategies.

Like other low-and middle-income countries (LMICs) in the region, Rwanda is more severely affected by climate change hazards. Rwanda's climate risk profile highlights the significant vulnerability of flooding and landslides to severe damage. These events cause death, injuries and substantial agricultural and environmental degradation.[23] Changes in weather patterns, such as prolonged droughts and heavy rainfall, have been shown to have a significant impact on the country's food security and economic stability.[23] The most recent report from the Ministry of Emergency Management (MINEMA) indicates that in May 2023, floods and landslides in the Western Province, including Rubavu District, resulted in 135 deaths, with 28 occurring in Rubavu District alone. The disaster displaced more than 5,159 households and 5,055 individuals, causing significant damage to assets and infrastructure. Nationally, 1,004 water supply systems, 20 national roads, eight water treatment plants, and four health facilities were damaged. Specifically, one health facility in Rubavu District was damaged.[15]

Given that the PLHIV requires regular healthcare follow-ups, such as access to healthcare services like adherence to ARVs treatment and health services, it is evident that climate-related disasters can significantly disrupt their care and increase their vulnerabilities.

Although the Government of Rwanda, through the Rwanda Biomedical Centre (RBC), has developed national guidelines for the prevention and management of HIV, there is limited scientific literature documenting the specific vulnerabilities of PLHIV and their adaptive strategies in response to climate change-induced hazards. This gap underscores the need for research to comprehensively explore the vulnerability and adaptive strategies of PLHIV in Rwanda to inform evidence-based decision-making.

Methods

Study design

This study employed a qualitative approach to explore the vulnerabilities and adaptation strategies of people living with HIV in response to climate change-induced hazards. An exploratory qualitative design was used.

Study settings

The study was conducted at Karambo Health Centre in Kanama Sector, Rubavu District. This health facility serves surrounding communities, and its catchment area was significantly affected by floods and landslides originating from the Sebeya River.

Selection of participants

The study employed purposive sampling to select Rubavu District due to its high vulnerability to climate change-exacerbated disasters, particularly as it borders the Sebeya River.[24] Simple random sampling was then used to select Karambo Health Centre from among the health facilities in the Kanama Sector most affected by floods and landslides.[25] The study population comprised people living with HIV, aged 18 years and above, who were enrolled at Karambo Health Centre. Researchers used the health Centre's registry to identify participants and contacted those with scheduled ARV service appointments during the data collection period.

Additionally, eight key informants (KIs) were selected based on their roles in the treatment of PLHIV, their involvement in the management of vulnerable populations, and the relevance of their expertise to the study's objectives.

Data collection procedure

A semi-structured interview guide with open-ended questions facilitated discussion on the themes. The guide was developed based on the study's specific objectives and expert input from specialists in public health, environmental health, and nursing. An expert group from the General Nursing and Environmental Health Sciences departments at the University of Rwanda validated the tool. The interviews focused on three main themes: the vulnerability of PLHIV, the challenges faced by PLHIV during Climate change-induced hazards and the adaptive strategies employed by PLHIV in response to Climate change-induced hazards. The key informant interviews, each lasting between 30 and 45 minutes, were conducted in semi-private locations chosen by the participants within their workplaces or selected by the coordinator of ARV services at the health centre. The focus group discussion with PLHIV lasted one hour, and the ARV services coordinator facilitated the identification of an appropriate location within the health centre for the session.

Prior to data collection, a training session was conducted to ensure that data collectors had a consistent understanding of the interview questions and the techniques for conducting interviews. Data collectors worked in pairs, one conducting interviews, the other taking notes and recording discussions. Data collectors obtained participants' permission to record. The interviews were conducted in the local language (Kinyarwanda). To avoid missing information and ensure data accuracy, the interview was transcribed into the local language (Kinyarwanda) and then translated into English. In addition, a professional translator was involved in maintaining consistency in translation. In addition, bilingual researchers familiar with disaster management, climate change, and nursing were included in the process to minimise language and technical issues specific to this field.

Data Analysis

The data were manually analyzed using thematic analysis to explore the perspectives of people living with HIV (PLHIV) on their vulnerabilities to climate change-induced hazards, their adaptive strategies, and the challenges they face during disaster events. The inductive approach was used to identify the patterns and themes and generate insights from the data and the questions asked in the interview guide. Researchers followed steps like theme identification, coding, naming, reviewing the themes, rechecking the overlaps, and validation by the experts. To increase the study's validity, researchers organized peer-reporting meetings with experts in the fields of climate change, nursing, and HIV, who discussed the results and interpretation of the study in depth.

Ethical considerations

Ethical clearance was obtained from the Institutional Review Board (IRB) of the College of Medicine and Health Sciences of the University of Rwanda (CMHS /IRB / 154/2024). The management of the Rubavu District provided permission to collect data (1388/07.0303/HRM/24). Participants were informed of the study's purpose, its benefits and risks, and the right to participate or withdraw at any time. They were also assured that their data would be kept confidential and used only for academic purposes. Before data collection began, the informed consent was obtained from all participants.

Results

Social demographic characteristics of participants

Most participants (70.2%) were female, while 29.8% were male. Regarding educational attainment, 22.8% had not attended school, 26.3% had completed primary education, and 50.9% had attained secondary education or higher.

In terms of age distribution, a significant number (33.3%) of participants were between 31 and 43 years old. Concerning marital status, 68.4% of the respondents were married.

Climate change vulnerabilities and adaptive strategies

The participants presented different views regarding the local climate change-induced vulnerability and coping strategies. Three main themes were identified, including the vulnerability of PLHIV, the challenges of climate change and the adaptation strategies as indicated in (Table 1).

Table 1. A comprehensive summary of the themes, sub-themes and codes

Themes	Sub-themes	Code description
PLHIV Vulnerabilities in Climate Change Contexts	Displacement and Loss of Shelter	Homeless and displaced people look for a nearby shelter
	Climate-related health effects on PLHIV	Inaccessibility of health services due to landslide roadblocks
	Food insecurity and medication adherence in PLHIV	Hunger, combined with the skipping of medications, triggered opportunistic infections.
	Income loss and economic hardships in PLHIV	Economic hardships include a lack of regular jobs in the areas, which renders poor lives and poor health conditions.
Challenges faced by PLHIV during Climate change-induced hazards	Limited access to climate change-related information	Lack of information channels and knowledge gaps among local leaders Unawareness of climate risks or how they affect health
	Inadequate social and economic support systems	Insufficient support mechanisms and local financial burden for house provisions and lack of local job opportunities
Adaptive strategies among PLHIV in the face of climate-related hazards	Coping strategies which three key dimensions (household adaptive strategies, community-based adaptive strategies, and institutional support mechanisms	Storing the properties of their neighbors, sharing food and counselling, *the* collaboration between government, private sector, and local communities

PLHIV Vulnerabilities in Climate Change Contexts

This main theme emerged from the following subthemes: displacement and loss of shelter, climate-related health effects on PLHIV, food insecurity and medication adherence and income loss, and economic hardships in PLHIV.

Displacement and loss of shelter

Participants indicated that they experienced severe climate change hazards. They suffered the loss of personal property, including houses and other personal belongings, underscoring the elevated severity of the hazard, as noted by the participants who emphasized the extreme damage caused by these hazards. Some of the participants confirmed relocation due to a lack of shelter, as climate change-induced hazards destroyed their houses.

"Around 9 PM, a heavy rainfall caused a series of events that changed our lives dramatically. The intense storm knocked down electrical wires, sparking a fire that engulfed our home. . Everything was destroyed; nothing was left except my cousin's bicycle, which we managed to save as we fled.

Suddenly homeless, we took shelter at my uncle's house, but just a few days later, a flood devastated their home as well. This forced us to relocate to Rugerero camp for a while".(R3 FGD6)

"The flood destroyed our home, and I had no choice but to take my child and leave. Most of our belongings were swept away, and we were forced to relocate to a displacement camp". (R1FGD2)

Climate-related health effects on PLHIV

Participants reported being on antiretroviral therapy (ART) and noted that climate change–induced hazards, such as floods, had destroyed road networks leading to health facilities. In some cases, the healthcare facilities themselves were damaged. They also indicated that these hazards disrupted the provision of care by local providers, such as peer educators, who were personally affected by the events. As a result, participants experienced reduced access to healthcare services, which in turn hindered their adherence to HIV treatment.

"Flooding surrounded the area and caused people to migrate; no one would think to go to the health centre for treatment. With numerous erosions that posed threats, visiting the health centre was not a priority. Our immediate focus was on survival, and the thoughts of medication followed." (R4 FGD5)

"For those of us living close to the health centre, accessing health services was not overly challenging. Nevertheless, for people who live far from health centres, it was difficult for them; even visiting them and getting food was not easy, as roads were damaged. " (R1 FGD5)

"Personally, as a peer educator, I faced the challenge of being unable to visit my peers and see how they are coping. I was not even able to go to the health centre because of the destruction of the road." (R2 FGD1)"

Participants revealed that the climate-induced hazards affected the medication intake due to many factors, especially lack of access to healthcare facilities and *loss of all belongings.* They indicated that in addition to inaccessibility to the Health Centre, climate change-induced hazards disrupted regular medication intake.

"During the disaster period, some people did not take their medications, especially since the floods washed some away." (R1 FGD6)

"The disaster greatly affected me as all my belongings and even my medications were washed away. Due to stress and struggle for a living, it took me two weeks to decide to return to the health centre to get other medications." (R2 FGD6)

"I had several issues to address at home before attending to my medication needs." (KI-4)

Food insecurity and Opportunistic Infections in PLHIV

Participants stated that hazards resulting from climate change increased their vulnerability since they caused food scarcity, which resulted in poor nutrition status and opportunistic infections. This became a huge problem when it came to PLHIV, as their continuous lifelong medication complements proper nutrition. They indicated that climate change-induced hazards negatively affected agriculture, leading to increased food insecurity. Although PLHIV requires a balanced diet, obtaining sufficient food during these periods became particularly challenging.

"As PLHIV, we are required to have a good amount of food and also nutritious food for the medication to work properly and not cause us any further health problems; so, due to loss of crops, we took the medication which caused us to suffer stomachache. Some of us decided to quit medications, which resulted in the rise of opportunistic infections." (R1 FGD1)

"For me, in the aftermath, I was sent to a refugee camp because my house was destroyed, and I was not taking medication at that time, as floods washed them away.

I started suffering from opportunistic infections and diseases caused by poor sanitation. After a while, I left the camp, and then I was able to go to the hospital/ health facility to get the medications; however, those medications did not fit me because I was taking them without eating properly. " (R2 FGD1)

"Obtaining food is a constant struggle; this often leads to a loss of hope. Furthermore, the scarcity of food often results in us skipping medications, leaving us vulnerable to opportunistic infections." (KI-3)

Income loss and economic hardships in PLHIV

Participants reported job losses as a direct consequence of climate-related events like flooding and landslides. Flooding has damaged businesses and farms. As a result, many are experiencing or are at risk of poverty, which limits their ability to afford basic necessities required for proper adherence to HIV treatment.

“Businesses were damaged by flooding. The loss of jobs and the struggle to pay for food have made life extremely difficult. This has affected our health, particularly for us who are on medication. The impact has been intense." (R2 FGD7)

"Personally, I owned a sewing machine, but the floods ruined it. Now, I'm trying to find any job to see if I can survive." (R5 FGD7)

“I used to work on farms that were destroyed by floods. Our biggest challenge now is poverty and the lack of a steady income, which also affects our ability to secure adequate shelter. Accessing food is a constant struggle, and even when we find some, the absence of kitchen facilities makes meal preparation difficult. This situation often leads to a sense of hopelessness." (KI-3)

Challenges faced by PLHIV during Climate change-induced hazards

Under the theme of challenges faced by PLHIV in response to climate change hazards, researchers formed two subthemes: limited access to climate change-related information and inadequate social and economic support systems. Most participants highlighted challenges and barriers they face in responding to and adapting to hazards induced by climate change.

Limited access to climate change-related information

The lack of awareness among PLHIV and peer educators about the hazards induced by climate change presents a critical barrier to effectively responding to the hazards caused by climate change.

"Lack of awareness as peer educators on climate change-induced hazards, it is challenging. It is difficult to help others without sufficient knowledge on climate change-induced hazards." (R3 FGD5)

“Our knowledge about the impact of climate change on health is limited. We hope that the government will strengthen health education on climate-related health risks” (KI-1)

Inadequate social and economic support systems

Participants reported that insufficient social support presents a significant barrier to the ability of PLHIV to respond to climate change-related hazards effectively. Social support networks are essential for providing emotional support, practical assistance, and access to resources during times of crisis. The absence of strong support systems increases the vulnerability of PLHIV to the adverse impacts of climate change.

"Lack of a social support network specifically for PLHIV…….it is not easy for us to help our colleagues without other help, as we also face the negative impacts of climate change. It is challenging." (R4 FGD4)

"I do not think that support mechanisms are enough; if we get other support, especially in terms of finance, it can be better, as it is still a challenge to get shelter and work for a living." (KI-2)

Adaptive strategies among PLHIV in the face of climate-related hazards

Under this theme, the researcher identified one sub-theme, Coping Strategies, which comprises three key dimensions: household adaptive strategies, community-based adaptive strategies, and institutional support mechanisms.

Household Adaptive Strategies

Participants indicated that they relied on their own resources and initiatives to adapt to climate change-related hazards, often seeking solutions independently without external support.

"Water entered my house; I tried to save a few of my belongings and my medications, as I always keep essential items in plastic bags. We tried to drainage water to avoid them destroying our houses"(R 5 FGD5)

"After the flooding washed our property and crops, we were required to go to the refugee camp, but we are living with HIV, and life in the camp was not easy. We adopted packing the medication in plastic bags so that in other times of disasters, our medication would be safe" (R 2 FGD2)

Community-based adaptive strategies

During traumatic events such as floods and landslides which destroyed homes and, in some cases, resulted in the loss of family members, community support and cooperation played a crucial role. Participants reported receiving assistance from neighbors in adapting to these disasters. Both emotional and practical support were provided, including help with rebuilding damaged houses after disasters and draining water during floods. Community-based support also involved actions such as safeguarding neighbors' belongings, sharing food, and offering emotional counselling, among other forms of solidarity.

"As I was saying, some neighbors who were able to help did so, either by lodging us and giving some food to eat." (R1FGD 6)

"They provided emotional and practical assistance when possible, such as helping to rebuild damaged houses due to floods." (R1 FGD 4)

"Community members who were less affected by climate change-induced hazards assisted others by safeguarding their belongings." (R4 FGD 5)

Institutional Support Mechanisms as Adaptive Strategies

Participants reported that various forms of support were provided to help PLHIV adapt to the hazards associated with climate change. Many individuals affected by disasters were temporarily relocated to refugee camps, where they received assistance. Following the closure of the camps, local leaders facilitated the rental of houses for those whose homes had been destroyed. Overall, participants noted that post-relocation support was extended, with special considerations given to PLHIV.

"We provide support with consideration for vulnerable people, including children, pregnant women, and PLHIV. In the package provided, PLHIV were considered and provided with medications and porridge to those who were malnourished" (KI-2)

"Igire gimbuka paid medical insurance for some groups of PLHIV, and the government is supporting people who were affected by climate change-induced hazards by building them houses and toilets, and we have received SOSOMA tones to help malnourished PLHIV." (KI-5)

Participants revealed the need for continuing support for PLHIV so that they can continue to survive. They indicated that the government and different stakeholders should help vulnerable PLHIV get something to do for a living. The participants also requested additional support to help existing ones in nutrition and financial support in rebuilding homes, as they were not enough.

"People Living with HIV (PLHIV) face numerous challenges, as sustaining a livelihood and securing adequate housing are essential aspects of wellbeing. These challenges increase their vulnerability and highlight the need for coordinated support from the government and other stakeholders to promote their health and resilience." (KI-2)

Participants emphasized the need for government support through access to loans and vocational training programs to enable income generation. These measures were identified as essential home-based solutions and adaptive strategies to enhance resilience to climate-related hazards.

Discussions

This study aimed to explore the vulnerabilities and adaptive strategies of PLHIV to climate change-induced hazards in Rubavu District, Rwanda. The findings indicate that climate change-induced hazards were severe and had significant adverse effects on the daily lives of PLHIV, exacerbating their vulnerabilities. The study also found that PLHIV employed various adaptive strategies in response to these hazards, including household, community, and institutional-level adaptive mechanisms. Furthermore, the findings highlight the need for financial support to enable PLHIV to enhance their adaptive capacity.

The current study's findings showed that climate change-induced hazards negatively impact people's properties, including houses and other personal belongings. Additionally, people were forced to relocate to safer areas. These findings align with the findings of another study on extreme weather events and HIV,[26] which reported that the cyclical nature of the wildfire season was particularly traumatizing to PLHIV, especially those who were unhoused or had experienced multiple losses, confirming that PLHIV face greater vulnerability. Also, our findings indicated that PLHIV who lost their properties experienced significant disruptions in their daily lives. This aligns with the findings of another study, which revealed that the inability of PLHIV to recover is related to asset loss and illness, which in turn leads to a loss of social capital, which constitutes a crucial coping strategy during emergencies.[27] These findings highlight the compounded vulnerabilities of PLHIV, as climate change-induced hazards disrupt livelihoods and may also worsen health and wellbeing.

The current study found that flooding and landslides affected essential public and private infrastructure, including healthcare facilities and road networks. Such a situation disrupted their access to healthcare services to adhere to HIV treatment, as one participant emphasized. These findings are consistent with similar research works conducted in different parts of the world. For instance, Anthonj et al, explored the vulnerability of PLHIV during floods and it was revealed that infrastructure damage restricted mobility and access to necessities, affecting medication adherence and WASH facilities, ultimately leading to declining health service delivery.[28] Another study conducted by Saberi et al. reported similar challenges faced by PLHIV during extreme weather events, the reluctance to leave evacuation zones due to fear of not being able to return, and the disruption of medication access caused by road closures.[29]

Further research has identified systemic barriers during wildfires to PLHIV, such as non-functioning medication mail delivery, pharmacy closures, restricted access for clinic staff, and transportation issues. These challenges have hindered the provision of healthcare services to PLHIV, particularly in rural areas.[29] Another study found that the inaccessibility of health services due to disasters such as flooding negatively affected healthcare-seeking behaviour and adherence to antiretroviral therapy (ART), with 23% of people interviewed in the Ohangwena region in Namibia, missing their medication.[28] It is reported that climate change is expected to worsen infectious diseases, with untreated HIV individuals at increased risk. For example, in Namibia, 53% of HIV-related opportunistic infections rose during floods.[28] These findings support the results of the current study, as they highlighted the impact of limited access to healthcare services on medication adherence for PLHIV. Beyond health risks, climate change also worsens food insecurity and nutrition, affecting PLHIV's wellbeing.

Findings from the current study indicate that climate change hazards contribute to food scarcity, resulting in poor nutrition and opportunistic infections. This is particularly concerning for PLHIV, who require a balanced diet to support medication adherence and maintain overall health. This is supported by the findings of other studies highlighted that the repercussions of food insecurity, including weight loss, low body mass index (BMI), decreased levels of albumin, and deficiencies in micronutrients, have been demonstrated to predict opportunistic infections, decline in immune function, and shorter survival time in both untreated and ART-treated individuals. Additionally, the absence of adequate food intake may hinder the optimal absorption of certain antiretroviral medications, potentially leading to treatment failure.[18, 30] Therefore, PLHIV faced heightened vulnerability due to poor nutrition, medication disruption, and increased opportunistic infections.

Findings from the current study indicate that climate change-induced hazards have negatively impacted employment and business opportunities for PLHIV. This situation increases their vulnerability to poverty, limiting their ability to afford essential resources needed for proper medication adherence. Other research works support our study findings by explaining how vulnerable people are victims of disasters.[23, 31] In this study, participants emphasized the detrimental impact of climate hazards. They stated that their biggest challenge is poverty and the absence of a steady income, affecting their ability to secure adequate shelter. Furthermore, food scarcity often results in skipping medication, leaving them vulnerable to opportunistic infections. Literature reports that poverty significantly increases vulnerability to HIV/AIDS by limiting access to healthcare services.[32] This emphasizes the importance of economic resilience, including the capacity to recover from hazards, referred to as resilience to livelihoods, when analyzing vulnerability.

The current study revealed that PLHIV face several challenges related to climate change-induced hazards. These include limited climate change information access and inadequate social and economic support systems. These findings contrast with those of a study conducted in Namibia's Ohangwena Region. The study highlighted that PLHIV received climate change-related information from volunteers trained by the Ministry of Education. These volunteers were assigned to care for children in relocation camps and provided camp management training, covering different aspects.[28] The discrepancy between these studies could be attributed to efforts to raise awareness of responses to climate-induced hazards in Namibia. Regarding inadequate social and economic support systems, this study findings show that support mechanisms are not enough. This aligns with the findings of a study conducted in selected hospitals of the North Shewa Zone, Amhara Region, in Ethiopia. The study found that there is poor social support for PLHIV, and it contributes to reduced adherence to antiretroviral therapy. [33] Despite these challenges, PLHIV have developed various adaptive strategies to cope with climate change-induced hazards, aiming to protect their health and wellbeing.

The findings of the study indicate that PLHIV predominantly rely on self-reliant strategies to manage climate change-related risks, often developing coping mechanisms independently due to limited access to external support systems. These findings are consistent with those reported in the study conducted in India to explore the impacts of climate change on rural livelihoods and adaptation strategies employed by farmers and fishermen to enhance their resilience and ability to cope with the challenges posed by climate change hazards. The study reported that they adopted various adaptation strategies to combat the effects of climate change.[35] These strategies included modifications in farm management practices, migration to other areas or temporary relocation, and other context-specific adaptations.[35]

Although individual-level adaptation is crucial, it is often insufficient in the absence of community networks and institutional frameworks to strengthen adaptive capacity in the face of climate-related hazards.

The study findings highlight that people living with HIV (PLHIV) receive various forms of community support to facilitate their adaptation to climate change-induced hazards. Emotional and practical support is provided when feasible, including assistance with rebuilding damaged homes during periods of flooding. These observations are consistent with the findings of the study conducted in Nigeria on the impact of care and social support on wellbeing among people living with HIV/AIDS,[36] which emphasized the crucial role of community support, both emotional and practical, in helping PLHIV adapt to the hazards resulting from climate change. The provision of emotional support and practical assistance, such as rebuilding houses, exemplifies how community resilience initiatives and social support networks can enhance the adaptive capacity of people living with HIV (PLHIV) in the face of climate-related challenges.[36]

Moreover, the findings of the current study are supported by the results of another study conducted in Kenya entitled Challenges Faced and Coping Strategies Adopted by Family Caregivers to Deal with People Living with HIV/AIDS in Thika District[33] indicated how individuals were able to employ resources provided by the community members as well as getting food provided by neighbors as an adaptive strategy to deal with challenges and build resilience. [37] This also supports our study findings, highlighting the importance of community support for those affected by floods. This reliance on community support shows the importance of strong social bonds, reciprocal relationships, and a sense of collective responsibility to improve adaptive capacity, especially for vulnerable populations facing environmental, economic, or other stressors, including climate-change-induced hazards.

The findings indicate that people living with HIV (PLHIV) received targeted assistance during periods of crisis, facilitated by various institutions aiming to reduce community vulnerability to climate-related hazards. These findings align with a report by the Rockefeller Foundation in Uganda, which demonstrated that multi-stakeholder collaboration led to the development of an adaptation plan for the health sector, thereby enhancing its resilience to climate-related impacts.[39] Other scholars illustrated the importance of institutional contribution in the management of hazards resulting from climate change.[40] These findings highlight the significant role of public and private health institutions, governmental agencies, and non-governmental organizations in supporting populations, including people living with HIV (PLHIV), to adapt to climate change hazards. These findings indicate the crucial role of various institutions in supporting people affected by climate change hazards, including PLHIV. While efforts have been made to support PLHIV, there is a need for more sustainable interventions.

Limitations

This study is limited by its qualitative nature, as the findings are based on the opinions and perceptions of individuals. Additionally, the results reflect the experiences of a specific group rather than a statistically representative sample, which may limit the generalizability of the findings. However, it has provided an in-depth understanding of the challenges and strategic options available to PLHIV to cope with climate change-induced hazards. These can be used to formulate analytical studies on a larger scale.

Conclusion

This study explored the vulnerability and adaptive strategies of people living with HIV (PLHIV) in the context of climate change-induced hazards. The findings indicate that PLHIV experience heightened vulnerability,including loss of personal property,

limited access to healthcare services particularly HIV treatment and food insecurity. To cope with these challenges, PLHIV employ various adaptive strategies, ranging from household-level responses to community and institutional support mechanisms. The study highlights the critical need to enhance the financial capacity of PLHIV as a means to reduce their vulnerability and strengthen their resilience to climate-related hazards.

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Conflict of interest
All authors declare no competing interests.

Authors' contributions
IL, EM, UB wrote the proposal, collected data, and wrote the first draft of the manuscript. NK supervised the work and revised the manuscript. BC, UAM and MCI provided critical input and editing.

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