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Climate Change-related Crises and Public Health Outcomes in Keta Municipality, Ghana

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Abstract

Background: Climate change impacts on public health is a great concern to governments of nations. Keta Municipality in the Volta Region of Ghana has been experiencing recurrent tidal waves, and these tidal waves have rendered some communities homeless and destroyed properties worth millions of dollars in 2025. The study assessed the effects of climate change crisis on public health and provided relevant solutions.

Methods: A concurrent mixed method design was employed in this study. A multi-stage was sampling used to select 422 study participants for the quantitative aspect of the study. Purposive sampling was employed to select study participants for the qualitative study. The quantitative data was analyzed using SPSS version 29.0. Multivariate regression analysis was applied in this study. The qualitative data was transcribed verbatim and analyzed using thematic content analysis with the help of Nvivo.

Results: The results showed that respondents with no formal education were 3.48 times more likely to rate their access to water as average rather than good (P=0.0027, OR =3.48). Respondents who had lived in the area for 11-30 years were 3.70 times more likely to rate their access to water as average compared to good (P=0.02, OR =3.70). A majority of respondents reported that previously reliable water sources had been lost due to tidal waves. A little over half of the respondents, 50.7% (n=214), rated their household food security as average. This reflects the inconsistent availability of food following tidal waves, flooding, and unpredictable rainfall patterns that have disrupted local farming and fishing activities. Conversely, 16.6% (n=70) rated their household food security as poor, highlighting vulnerability to food shortages and nutritional deficiencies. These households reported challenges such as loss of farmland to tidal waves, destruction of fishing equipment, and higher prices following climate events.

Conclusions: There was a notable lack of awareness about public or institutional measures to combat climate-health impacts. The study recommends Ghana Health Service should incorporate climate-health literacy into healthcare services and educational efforts aimed at increasing awareness of climate-related health issues be thoughtfully tailored to reach specific segments of the population that tend to less informed.

Background

Climate change has emerged as one of the most critical global challenges affecting public health, environmental sustainability, and socio-economic development. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as long-term alterations in atmospheric conditions resulting directly or indirectly from human activities that modify the composition of the global atmosphere beyond natural climatic variability.[1] Anthropogenic activities particularly greenhouse emissions from industrial processes, agriculture, and transportation are widely recognized as the primary drivers of climate change.[2–4] These changes have disrupted ecological systems,

reduced agricultural productivity, increased the frequency and intensity of extreme weather events, and intensified food and water insecurity, with significant implications for human health.

Globally, the impacts of climate change manifest through rising temperatures, environmental degradation, extreme weather events, sea level rise, and the increased prevalence of climate-sensitive diseases.[5–8] Climate change has also been linked to the resurgence of infectious and vector borne diseases, malnutrition, heat-related illnesses, and population displacement, further exacerbating public health vulnerabilities.[9] In response to these global threats, international frameworks such as the Paris Agreement were adopted to mitigate climate change and strengthen adaptive resilience, with 100 countries committees to collective climate action. [10]

Ghana became a signatory to the UNFCCC during the Earth Summit in Rio de Janeiro in 1992, demonstrating its commitment to addressing climate change at the national level.[11] Despite this commitment, the country continues to experience significant climate-related challenges, notably rising temperatures, altered rainfall patterns, and increasing sea levels.[12]These climatic changes have resulted in prolonged dry seasons, erratic rainfall, coastal flooding, declining agricultural productivity, and water scarcity.[13] Reduced rainfall has also affected hydroelectric power generation, placing additional strain on Ghana's socio-economic systems. Limited institutional capacity and challenges in implementing effective adaptation strategies have further constrained the country's ability to manage the health and environmental impacts of climate change.[14]

The Keta Municipality in the Volta Region of Ghana is among the most climate-vulnerable coastal areas in the country. For several decades, the municipality has experienced persistent coastal erosion, recurrent flooding, and tidal waves, exacerbated by sea-level rise, climate variability, human activities, and poor coastal ecosystem management.[15, 16] These environmental stressors have resulted in widespread displacement of residents, destruction of homes and infrastructure, loss of arable land, soil salinization, and declining agricultural yields. Economically important coconut plantations have been destroyed, while both lagoon and marine fish catches have declined, threatening livelihoods and food security.[15] A major tidal wave event in 2021 displaced over Seven hundred (700) residents in the Keta Municipality, rendering many households homeless and destroying properties worth millions of dollars. Recurrent flooding and saltwater intrusion have compromised freshwater sources, increased food prices, and heightened vulnerability to malnutrition and poverty. These environmental changes have also intensified public health risks, including increased exposure to waterborne diseases, vector-borne diseases such as malaria, and other climate-sensitive health conditions.[17]

Understanding the local and broader climatic drivers of these challenges, as well as their public health implications, was therefore critical for developing effective and context-specific adaptation strategies. This study examined the effects of climate change-related crises on public health in the Keta Municipality of the Volta Region of Ghana, with the aim of generating evidence to inform policy,

strengthen community resilience, and contribute to the achievement of Sustainable Development Goal 13: Take urgent action to combat climate change and its impacts.

Methods

Study Design

This study employed a concurrent mixed methods design to investigate the climate change-related crises and public health outcomes the Keta Municipality. The quantitative part involved a cross-sectional survey that looked at how common certain health issues were and how they related to climate events. At the same time, the qualitative side of the research followed a phenomenological approach, focusing on the personal experiences of community members and key informants who had been affected by these disruptions. Combining both methods gave a fuller picture of the situation.

Study Setting

The research was carried out in Keta Municipality, located in the Volta Region of Ghana. This area was selected due to its long-standing exposure to recurring tidal waves and other forms of climate variability. Keta Municipality is one of the twenty-six administrative districts in the region and is among the oldest. From 1993 to 2023, Keta Municipality within Ghana's coastal savannah zone has exhibited clear signs of climatic change. Rainfall averaging historically 800mm/year has become increasingly erratic, with inter-annual fluctuations now ranging between approximately 980-1,340 mm, reflecting heightened variability and extended dry spells. Over the same period, mean temperatures have risen by around 1^{o}C, evidenced by increases in both minimum and maximum daily temperatures and more frequent waves.[18]

Study population

The population comprised community members aged 18 years and above, aligning with Ghana's legal age for providing informed consent as stipulated in Article 28(5) of the 1992 Constitution, which defines a child as a person below eighteen years of age. Consequently, the study population comprised both male and female adults, including staff from the Environmental Protection Authority, Environmental Health Officers, and National Disaster Management Organization officials.

Inclusion Criteria

This study included individuals aged 18 years and above regardless of their ethnic backgrounds or religious affiliation.

Exclusion Criteria

This study however excluded those who were qualified and listed but were unwell during the data collection.

Sample size determination

To determine an appropriate sample size for a cross-sectional survey with categorical outcomes, Cochran's formula (1977) was employed.

The Cochran formula is given by:

$$n = \frac{Z^2 p(1-p)}{d^2}$$

.

This was calculated as: (1.96)2(0.5) (1- 0.5)/ (0.05)2; 384.16 = 384. Nonresponse of 10% was added (38), summing up to 422.

Sampling technique

This quantitative aspect of the study employed a multistage sampling to select four hundred and twenty-two (422) respondents from three communities: Keta Central, Kedzi, and Abutiakope, all within the Keta Municipality. Purposive sampling to select respondents for the qualitative aspect. At the first stage, a list of all communities in the Keta Municipality was obtained from the Municipal Assembly.

From this list, communities that had been severely affected by tidal waves and related climate change crises were identified in consultation with Municipal National Disaster Management Organization (NADMO) office and local opinion leaders. Based on the severity of impact, Keta Central, Kedzi, and Abutiakope were selected.

At the second stage, within each selected community, a list of households that had experienced displacement, property loss, or other significant effects from tidal waves was compiled with the help of community leaders and NADMO records. From these lists, households were randomly selected using simple random sampling by assigning numbers and drawing lots until the required size each community was achieved proportionate to its population of affected households. In households with more than one eligible adult member aged 18 years and above who was resident during the tidal wave events, one respondent was randomly selected using simple methods like balloting. Where a selected individual refused to participate in the study, resampling was conducted to replace such individuals. For the qualitative aspect of this study, a purposive sampling strategy was used. This approach fell under the broader category of non-probability sampling techniques. It involved the deliberate selection of individuals who were especially knowledgeable or experienced in relation to the subject being studied.

Data collection

The questionnaire were developed based on literatures reviewed and is attached as supplementary file. Structured questionnaire was used to collect data. The questionnaire was close-ended or multiple-choice

questions that required respondents to choose from already listed possible answers provided by the researcher. The development of the questionnaire was informed by the specific objectives and the literature review. The questionnaire was categorized into six sections. Section A elicited information on the bio data of the respondents. Section B contained information on the change in climate and access to drinking water supply. The questionnaire was administered by the researcher and research assistants. Each question was read, interpreted into the local language (Ewe) for those who did understand English. Whilst the qualitative employed Key infant interview and focus group discussions in eliciting the responses.

Study variables

The study variables measured in this study comprised both dependent and independent variables. In this study, the dependent variable was the climate change-related crises and public health outcomes. This included how climate change affected access to drinking water and food supply, the occurrence of climate-related diseases, and the coping strategies people used in response. The independent variables were the socio-economic characteristics of the population, such as age, gender, and marital status, level of education, religion, occupation, and language. Other independent variables included changes in climate and their effects on water access and food security, the prevalence of climate-linked diseases, and the different coping methods people used to deal with health impacts caused by climate change.

Data analysis

Quantitative data were analyzed using SPSS version 29.0 and Microsoft Excel. Following data collection, responses were cleaned, coded, and double entered to ensure accuracy and consistency before statistical analysis. Descriptive statistics were used to summarize respondents' socio-demographic characteristics, with cross-tabulations performed between sex and key variables such as age, educational level, and marital status. Multivariate regression analysis was applied to examine associations between dependent variable and socio-demographic predictors. Results were interpreted using odds ratios and p-values to identify statistically significant relationships, and findings were presented in tables and bar charts. Qualitative data from key informant interviews and focus group discussions were audio-recorded, transcribed verbatim, and carefully reviewed to preserve participants' intended meanings. Transcripts were imported into NVivo 11 for thematic analysis. An inductive approach was used to identify recurring patterns and themes related to climate change, water access, water quality, and health concerns. The integration of quantitative and qualitative analyses enabled triangulation of findings and provided a comprehensive understanding of community perceptions and experiences.

Ethical Considerations

This study was reviewed and approved by University of Port Harcourt Ethics Review Committee and Ho Teaching Hospital Ethics Review Committee (Protocol ID NO**: HTH-REC (26) FC_2024**). The research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Consent Process

Verbal informed consent was obtained from all participants prior to data collection, as approved by the ethics committee. Participants were informed of study objectives, their right to withdraw at any time, and assurances of confidentiality.

Permission from Study Area

Permission to proceed with the study and copies of ethical clearance was made available to institutions that were concerned. Further permission was granted by Keta Municipal Health Directorate.

Voluntary Participation and Withdrawal

The study respondents were informed about the fact that participation in the study was voluntary, and they have the right to withdraw from the study at any point in the study without any consequence. The informed consent form was done in languages and translated in Ewe, and it was given to the respondents based on the language they understand. For those who cannot read, it was read and interpreted to them.

Benefits and risks to participants

There was no direct benefit to study participants for participating in this study. However, recommendations from this study would help to find amicable solutions to climate change issues in the Municipality and nation at large.

Anonymity and Confidentiality

The Principal Investigator (PI) ensured anonymity by not taking the names of the respondents in consideration. To ensure privacy and confidentiality, participants were not required to provide their names. The study participants were given some coded IDs. The data analysis and reporting were done using the IDs.

Compensation

There was no compensation for study participants who agreed to participate in the study.

Data protection

Data collected were password protected. Soft and hard copy were stored locked, and access was limited only to Principal Investigator and Project Supervisor.

Data Storage

The study participants were assured confidentiality of information provided. All responses were coded in a way which cannot link to any of the participants. Copies of the analysis were sent to the Principal

Investigator’s email to guard against data loss.

Conflict of interest

The Principal Investigator had no conflict of interest in this study.

Results

Socio-demographic characteristics of Respondents

The study explored the socio-demographic characteristics of respondents and the summarized in Table 1. There was a total of 422 respondents who participated in the study.

Table 1: Socio-demographic characteristics of respondents

Variable	Frequency	Percentage (%)
Age		
18-39	170	40.3
40-60	157	37.2
60 and above	95	22.5
Sex		
Male	239	56.6
Female	183	43.4
Religion		
Christianity	346	82.0
Islam	76	18.0
Tribe		
Ewe	326	77.3
Akan	54	12.8
Hausa	42	10.0
Educational level		
No formal education	35	8.3
Primary	85	20.1
JHS	91	21.6
SHS	93	22.0
Tertiary	118	28
Marital status		
Married	155	36.7
Single	215	50.9
Separated	52	12.3
Employment status		
Employed	189	44.8
Pensioner	95	22.5
Unemployed	138	32.7

Occupation		
Farmer/Trader	152	36.0
Public employee	104	24.6
None	166	39.3
Length of stay		
1-10yrs	131	31.0
11-30yrs	223	52.8
31-60yrs	68	16.1

Source: Field report, 2024

The majority were aged 18–39 years (40.3%), followed by those aged 40–60 years (37.2%), while 22.5% were aged 60 years and above. More than half of the participants were male (56.6%), with females representing 43.4% of the sample. In terms of religion, 82.0% identified as Christians and 18.0% as Muslims. Ethnically, the Ewe group constituted the majority (77.3%), followed by Akan (12.8%) and Hausa (10.0%). Educational attainment varied among participants, with 8.3% having no formal education, 20.1% attaining primary education, 21.6% completing Junior High School (JHS), 22.0% completing Senior High School (SHS), and 28.0% attaining tertiary education. Regarding marital status, 50.9% were single, 36.7% were married, and 12.3% were separated. Employment status data revealed that 44.8% were employed, 32.7% unemployed, and 22.5% were pensioners. Occupationally, 36.0% of respondents were farmers or traders, 24.6% were public employees, while 39.3% reported no occupation at the time of the survey. Length of stay in the community also showed variation, with the majority (52.8%) residing in the community for 11–30 years, followed by 31.0% who had stayed for 1–10 years, and 16.1% for 31–60 years.

Climate change and respondents' rating of their access to water

A perception-based assessment, common in community-level surveys, to gauge access to safe drinking water, focusing on availability and quality as experienced by residents rather than physical testing or infrastructure data was used to assess access to drinking water. This captured respondents' subjective experiences and perceptions about the quality and availability of drinking water in their environment. It reflected not only the actual access to water but also the social, economic, and environmental conditions that influenced how people experience water security in their daily lives. The educational level of respondents (No education) had a statistically significant association with respondents' rating of their access to water as average (P = 0.027, OR = 3.48) as compared to their rating their access to water as good. This implied that for every unit increase in respondents not having no education, the respondents were 3.48 times more likely to rate their access to water as average as compared to rating it as good. Also, the length of stay (11 – 30 years) had a statistical association between respondents'

rating of their access to water as average (P = 0.002, OR = 3.70) as compared to them rating it as good. This implied that for every unit increase in respondents' length of stay of 11 – 30 years, the respondents were 3.70 times more likely to rate their access to water as average compared to them rating it as good. However, the educational level of respondents (primary) had a statistically significant association with respondents' rating of their access to water as poor (P = 0.004, OR = 3.19) as compared to them rating their access to water as good. This implied that for every unit increase in a respondent's having a primary education, the respondent was 3.19 times more likely to rate their access to water as poor as compared to rating it as good. Also, occupation (farmers/traders; public employees) had a statistical association between respondents' ratings of their access to water as poor (P = 0.01, OR = 4.09; P = 0.07, OR = 1.92) respectively as compared to them rating it as good. This implied that for every unit increase in a respondent's having had a primary education, the respondents were 3.19 times more likely to rate their access to water as poor as compared to them rating it as good. This implied that for every unit increase in a respondent's occupation being farming/trading, they were 4.09 times more likely to rate their access to water as poor as compared to them rating it as good and those who were public employee were 1.92 times more likely to rate their access to water as poor as compared to them rating it as good.

Table 2: Association between the socio-demographic characteristics of respondents and their ratings of their access to drinking water.

Independent variables	Statistic			
	Log odds	SE	Odds ratio	P-value
AVERAGE				
Age				
60 and above (Ref)				
18-39	-0.412	0.389	0.662	0.289
40-60	-0.188	0.366	0.829	0.608
Sex				
Female (Ref)				
Male	-0.165	0.254	0.848	0.516
Religion				
Islam (Ref)				
Christianity	0.044	0.447	1.045	0.921
Tribe				
Hausa (Ref)				
Ewe	-0.301	0.664	0.74	0.651
Akan	-0.053	0.746	0.949	0.944
Educational level				
Tertiary (Ref)				
No formal education	1.25	0.567	3.489	0.027
Primary	0.46	0.35	1.584	0.188
JHS	-0.083	0.384	0.92	0.828
SHS	-2.104	0.518	0.122	0.001
Occupation				
None (Ref)				
Farmer/Trader	0.248	0.422	1.282	0.557
Public employee	-0.072	0.319	0.931	0.822
Length of stay				
31-60yrs (Ref)				

1-10yrs	0.925	0.492	2.522	0.06
11-30yrs	1.309	0.418	3.702	0.002
POOR				
Age				
60 and above (Ref)				
18-39	0.42	0.408	1.522	0.303
40-60	-0.174	0.37	0.841	0.639
Sex				
Male (Ref)				
Female	0.164	0.269	1.178	0.542
Religion				
Christianity (Ref)				
Islam	0.13	0.499	1.139	0.794
Tribe				
Hausa (Ref)				
Ewe	-0.442	0.639	0.643	0.489
Akan	0.108	0.722	1.114	0.881
Educational level				
Tertiary (Ref)				
No formal education	-0.624	0.799	0.536	0.435
Primary	1.162	0.404	3.198	0.004
JHS	0.421	0.447	1.523	0.347
SHS	-0.356	0.465	0.701	0.445
Occupation				
None (Ref)				
Farmer/Trader	1.411	0.418	4.098	0.001
Public employee	0.657	0.362	1.928	0.07
Length of stay				

31-60yrs (Ref)				
1-10yrs	-0.103	0.492	0.902	0.834
11-30yrs	0.585	0.379	1.795	0.122

Source: Field report, 2024

Socio-demographic characteristics of respondents and their rating of food security in their household

The length of stay of respondents (1 – 10 years; 11 – 30 years) had a statistically significant association with a respondent rating of their overall food security in their household as average (P = 0.001, = 0.011; P = 0.001, = 0.191) respectively as compared to them rating it as slightly comfortable or good. This implied that for every unit increase in a respondent's length of stay being (1 – 10 years) and (11 – 30 years) respectively, the respondents were 0.011 times or 98.9 % and 0.191 or 80.9 % less likely to rate their overall food security in their households as average as compared to rating it as slightly comfortable or good. However, the educational level of respondents (SHS) had a statistically significant association with respondents' rating of their overall food security in their household as poor (P = 0.014, = 0.187) as compared to rating their overall food security in their household as slightly comfortable. This implied that for every unit increase in a respondent's having an SHS education, the respondent was 0.187 times or 81.3 % less likely to rate their overall food security in their household as poor as compared to rating it as good. Also, the length of stay had a statistical association between respondents' rating of their overall food security as poor (P = 0.001, OR = 0.013) as compared to them rating it as good. This implied that for every unit increase in a respondent's length of stay being (1 – 10 years), the respondent was 0.013 times or 98.7 % less likely to rate their overall food security in their household as poor as compared to them rating it as good.

Table 3: Association between the socio-demographic characteristics of respondents and their ratings of food security in their household.

Independent Variable	Category	Log odds	SE	Odds ratio	P-value
AVERAGE					
Age	60 and above (Ref)				
	18–39	0.156	0.435	1.169	0.72
	40–60	-0.8	0.428	0.449	0.062
Sex	Female (Ref)				
	Male	-0.087	0.278	0.917	0.754
Religion	Islam (Ref)				
	Christian	0.597	0.466	1.817	0.201
Tribe	Hausa (Ref)				
	Ewe	0.096	0.657	1.101	0.884
	Akan	0.946	0.758	2.576	0.212
Educational level	Tertiary (Ref)				
	No formal education	0.764	0.749	2.146	0.308
	Primary	0.25	0.386	1.285	0.517
	JHS	-0.099	0.441	0.906	0.822
	SHS	-0.294	0.454	0.745	0.518
Occupation	None (Ref)				
	Farmer/Trader	0.207	0.451	1.23	0.647
	Public employee	0.167	0.352	1.181	0.635
Length of stay	31–60yrs (Ref)				
	1–10yrs	-4.48	0.72	0.011	0.001
	11–30yrs	-1.654	0.644	0.191	0.001
POOR					
Age	60 and above (Ref)				
	18–39	-0.99	0.569	0.371	0.082
	40–60	-0.847	0.493	0.429	0.086
Sex	Female (Ref)				

	Male	-0.59	0.36	0.554	0.101
Religion	Islam (Ref)				
	Christian	0.72	0.74	2.055	0.33
Tribe	Hausa (Ref)				
	Ewe	-0.969	0.908	0.38	0.286
	Akan	-0.821	1.067	0.44	0.441
Educational level	Tertiary (Ref)				
	No formal education	0.007	0.947	1.007	0.994
	Primary	0.698	0.519	2.01	0.179
	JHS	0.353	0.568	1.424	0.534
	SHS	-1.678	0.682	0.187	0.014
Occupation	None (Ref)				
	Farmer/Trader	-0.053	0.556	0.948	0.924
	Public employee	-0.665	0.493	0.514	0.177
Length of stay	31–60yrs (Ref)				
	1–10yrs	-4.377	0.898	0.013	0.001
	11–30yrs	-0.949	0.71	0.387	0.181

Source: Field report, 2024

Respondents' ratings of awareness of prevalence of climate change associated with diseases

The chart illustrated respondents' perceptions of the prevalence of diseases associated with climate change. Out of the total sample, 63% (n = 266) of respondents affirmed the presence of climate-related diseases in their communities, while 37% (n = 156) reported no such awareness.

Association between the socio-demographic characteristics of respondents and their awareness of climate change associated with diseases

The age of respondents (18 – 39 years), educational level (JHS; SHS), occupational status (Farmers/Traders; Public employees) and length of stay had a statistical significant association with respondents not being aware of climate change associated diseases in their community (age P = 0.001, OR = 4.71; educational level (JHS) P = 0.025, OR = 2.77; educational level (SHS) P = 0.021, OR = 2.77; occupational status (Farmers/Traders) P = 0.002, OR = 0.287; occupational status (Public employee) P = 0.001, OR = 0.233); length of stay P =0.001, OR = 14.32) as compared to them being aware of climate

change associated diseases in their community. This implied that for every unit increase in a respondents age (18 – 39 years), educational level (JHS), educational level (SHS), occupational status (Farmers/Traders; Public employee), and length of stay (1 – 10 years) the respondents were 4.71 times more likely not to be aware of climate change associated diseases in their community, 2.77 times more likely, 2.72 times more likely, 0.287 or 71.3 % less likely, 0.233 or 76.7 % less likely and 14.32 times more likely not to be aware of climate change associated diseases in their community as compared to them being aware of climate change associated diseases in their community respectively.

Measures taken by government, community or local authorities to address climate change-related health issues

The graph illustrated public perceptions of government and community measures implemented to address climate change-related health issues. The results indicated that 47.4% (n = 200) of respondents acknowledged the existence of such measures, while a slightly higher proportion, 52.6% (n = 222), reported no awareness of any intervention. This near parity highlighted a substantial divide in awareness or implementation, with a marginal majority indicating an absence of coordinated efforts by the government or other authorities.

Qualitative Results

Key Infant Interviews

This section presented the qualitative findings from the in-depth interviews conducted to explore the effects of climate change-related crises on public health in the Keta Municipality of the Volta Region of Ghana.

Table 4: Prominent themes from the key informant interviews on climate change and access to water (n=58)

Themes	Themes Frequency
Water Scarcity & Reduced Supply	22
Water Contamination & Salinity	16
No Idea / No Response	12
Illegal Human Activities	8

Field Report, 2024

Water scarcity and reduced water supply, together with water contamination and water salinity, were the most prominent themes that emerged when respondents were asked to express their knowledge or

opinion on climate change regarding their access to drinking water in their community. These individualized experiences were shared:

"The tidal waves have made our drinking water unsafe. Seawater kept seeping into our wells, making them salty and undrinkable. We used to rely on these wells for clean water, but now we have to walk long distances to find freshwater sources. Even when we fetch water, it sometimes has a strange taste, which worries us about our health. Many people in my community were struggling because they couldn't afford to buy treated water every day."

Table 5: Prominent themes from the key informant interviews on climate change and household food security (n=58)

Themes	Themes Frequency
Increased food prices	39
More frequent food shortages	8
Decreased/food availability	7
No idea/No response	4

Source: Field report, 2024

Increased food prices together with more frequent food shortages were the most prominent themes that emerged when respondents were asked to express their knowledge or opinion on climate change on their household food security in their community. These individualized experiences were shared:

"The price of food has gone up so much that I could no longer afford the same quantity of food I used to buy. Climate change has made things worse because unpredictable rainfall and rising temperatures have affected crop yields. Farmers were struggling, and when their harvests were low, food became scarce and more expensive. I must reduce the portion sizes at home, and sometimes we skip meals. It's really affecting my family, especially the children."

Table 6: Prominent themes from the key informant interviews on climate change-associated diseases (n=58)

Themes	Themes Frequency
Vector-Borne Diseases (Malaria, Cholera, Typhoid, Dengue Fever, Fever)	38
Skin-Related Conditions (Skin diseases, Rashes, Irritation, One leg swelling, Salinity effects on skin)	8
Water and Food-Related Illnesses (Diarrhea, Dysentery, Waterborne diseases, Malnutrition, Kwashiorkor, Anemia)	7
Respiratory and Heat-Related Conditions (Lung diseases, Meningitis, CSM, Heat diseases, Drought effects)	3
No Idea / No Response	2

Source: Field report, 2024

Vector-borne diseases, together with skin-related conditions, were the most prominent themes that emerged when respondents were asked to express their knowledge or opinion on climate-related diseases in their community. These individualized experiences were shared:

"Malaria cases have become more frequent in my household, especially after heavy rains and floods. The stagnant water left behind creates the perfect breeding ground for mosquitoes. Before, we didn't have such persistent outbreaks, but now, every rainy season, someone in my family fell sick. Climate change has worsened the situation, as unpredictable rainfall and flooding make it harder to control mosquito populations."

Table 7: Prominent themes from the key informant interviews on climate change and coping mechanism (n=58)

Frequency	Themes Frequency
Lack of Awareness & Uncertainty	39
Awareness & Education	10
Adaptation Strategies & Community Initiatives	5
Government & Policy Interventions	4

Source: Field report, 2024

Lack of awareness and uncertainty, together with more awareness and education, were the most prominent themes that emerged when respondents were asked to express their knowledge or opinion on the climate change effect on coping mechanisms, which would aid in mitigating public health-related problems in their community. These individualized experiences were shared:

"I honestly did not know much about how climate change is affecting our health. We see the weather changing, but I have no idea if it's linked to the increasing illnesses in our community. I have never attended any awareness programme on this, and no one has explained how serious it is. If something is being done, I am not aware of it."

Discussion

The study was carried out to identify the respondents' knowledge, awareness, and perception and individual/community-level responses to climate change-related issues in the Keta Municipality of the Volta Region, Ghana. The discussion examined association between respondents' knowledge and awareness of climate change-associated issues such as change in water supply, food security, age, sex, tribe, religion, education, occupation, and length of stay.

Climate change and respondents' ratings of their access to water

Access to drinking water has been a fundamental determinant of public health, especially within communities vulnerable to the adverse impacts of climate change.[19] The findings of this study indicated that while certain socio-demographic characteristics such as age, sex, religion, tribe, and occupational status did not show statistically significant associations with respondents' rating of their access to water, educational level (no education) and length of stay (11–30 years) in the community emerged as significant predictors of perceived access to drinking water. Specifically, the study found that respondents with no formal education were 3.48 times more likely to rate their access to drinking water as average compared to those who rated it as good (P = 0.027, OR = 3.48). This finding was consistent with previous research which suggested that individuals with lower educational attainment often lacked adequate knowledge of water management practices, water safety procedures, and environmental protection, thereby limiting their ability to secure safe and sustainable water sources.[20,21] Furthermore, education enhanced individuals' awareness of the importance of safe water handling and conservation strategies within households and communities.[19] Additionally, length of stay in the community (11-30 years) was significantly associated with respondents' rating of their access to water as average (P = 0.02, OR = 3.70). This suggested that long-term residents might have observed a progressive deterioration in water sources over time, possibly due to climate variability, population growth, and human-induced environmental changes. Abraham et al. similarly reported that prolonged exposure to environmental degradation, including water pollution and declining rainfall patterns, significantly influenced residents' perceptions and experiences of water scarcity in coastal Ghana.[22]

Socio-demographic characteristics of respondents and their ratings of food security in their household

The study revealed that the age, sex, religion, tribe, educational level, and occupational status of respondents showed no statistically significant association with a respondent's rating of their overall

food security as average compared to them rating it as good. This finding contrasted with the argument by Ojo and Baiyegunhi [23], who indicated that socio-demographic factors such as age, education, and occupation often played crucial roles in determining food security status, particularly in rural communities vulnerable to climate change. Research revealed that educational level and occupation might influence households' resilience and adaptation strategies, thereby affecting food security.[24,25] The current finding, however, suggested that in the Keta Municipality, these socio-demographic characteristics might not necessarily influence respondents' perceptions of their household food security status. Interestingly, the study found that only the length of stay of respondents in the community had a statistically significant association with their rating of overall food security. Specifically, respondents who had stayed between 1 – 10 years (P = 0.001, OR = 0.011) and 11 – 30 years (P = 0.001, OR = 0.191) were less likely to rate their food security status as average compared to those who rated it as good. This implied that for every unit increase in a respondent's length of stay within the categories of 1 – 10 years and 11 – 30 years, the likelihood of rating their food security as average reduced by 98.9% and 80.9% respectively, relative to rating it as good. This finding aligned with the argument by FAO [26], who reported that the duration of residence in a community might provide households with better access to livelihood resources, social networks, and coping strategies that enhanced food security. Furthermore, long-term residents might have better knowledge of local climate adaptation practices and resource management, which might positively influence their food security status.

Association between the socio-demographic characteristics of respondents and their awareness of climate change associated diseases

The findings from this study revealed no statistically significant associations between respondents' sex, religion, or tribe and their awareness of climate change-associated diseases in their community. This aligned with previous research which suggested that demographic factors such as sex and ethnicity might not directly influence individuals' awareness of climate change-related issues. Instead, other factors, including education and occupation, might be more pivotal in shaping awareness.[27,28] However, the findings revealed statistically significant associations between age, educational level, and occupational status with respondents' lack of awareness of climate change-associated diseases in their community. Specifically, respondents aged 18–39 years were 4.71 times more likely to not be aware of climate change-associated diseases. This indicated that younger individuals might not be as aware of the health risks associated with climate change, possibly due to factors such as limited exposure to climate-related education, or less concern about the long-term effects of climate change.[29]

Conclusion

The study assessed the public health impacts of climate change-related crises in the Keta Municipality, focusing on how socio-demographic factors shaped community perceptions, awareness, and responses to challenges affecting water supply, food security, and climate-sensitive diseases. The findings showed

that perceptions of declining access to safe drinking water were significantly higher among individuals with no or primary education and among residents who had lived in the community for 11-30 years, suggesting that educational attainment and long-term environmental exposure influenced awareness of water stress. However, these associations were not consistent across all demographic groups, indicating that climate-related water challenges were widely experienced but unevenly perceived.

Household food security outcomes also revealed mixed patterns. While most socio-demographic factors showed no significant association, educational level (particularly SHS) and length of stay were linked to variations in perceived food insecurity. These findings highlighted that vulnerability to climate-induced food disruptions was context-specific rather than uniformly distributed across demographic categories. Awareness of climate change-associated diseases varied sustainability within the population. Younger adults (18-39 years), individuals with JHS or SHS education, and those with shorter to medium lengths of residence were more likely to lack awareness of climate-related health risks. Occupational status did not consistently predict awareness, underscoring that knowledge gaps were influenced by factors beyond demographic or professional characteristics alone.

Generally, the study revealed widespread limited awareness of public or institutional measures addressing climate-related health impacts, cutting across multiple demographic groups. This suggested systemic gaps in risk communication and community engagement rather than isolated deficiencies within specific populations. The findings emphasized the need for inclusive, context-sensitive climate-health interventions and improved communication strategies to enhance community resilience in climate-vulnerable coastal settings.

Recommendations

- **Tailor Education and Awareness Campaigns to Specific Subgroups**

Educational efforts aimed at increasing awareness of climate-related health issues should be thoughtfully tailored to reach specific segments of the population that tend to be less informed. This involved individuals with little to no formal education, as well as younger or newly settled residents in the area, who were observed to have lower levels of awareness in this regard. These groups might lack regular access to formal sources of information or might not have had the opportunity to engage with public education campaigns on climate and health. To effectively reach these populations, it would be important that educational initiatives went beyond conventional classroom settings.

- **Address Structural Barriers to Adaptation for Vulnerable Occupations**

There was a pressing need to strengthen the support systems available to farmers, traders, and individuals working in the informal sector, as they often experienced the brunt of climate-related impacts while having fewer resources to respond effectively. These groups typically operated without the social protections or institutional backing that formal employment might offer, making them particularly vulnerable when faced with droughts, floods, rising temperatures, or shifts in market availability caused

by environmental disruptions. Making microfinance services more accessible could provide a financial cushion that enabled them to invest in alternative livelihoods or protective measures.

- **Incorporate Climate-Health Literacy into Healthcare Services**

It was important that primary healthcare workers were equipped with the knowledge and tools necessary to educate the public on the health impacts of climate change. To do this effectively, they should receive targeted training that enables them to incorporate climate-related health information into the routine services they already provide. Since these healthcare workers often served as the first point of contact for many individuals seeking medical assistance, they were in a strong position to influence awareness and promote behaviour change. Health centers, especially those located within communities, could serve as reliable and trusted platforms for delivering consistent and practical information about how climate change was affecting health.

Abbreviations

UNFCCC	United Nations Frameworks Convention on Climate Change
NADMO	National Disaster Management Organization

Declarations

Ethics approval

This study was reviewed and approved by University of Port Harcourt Ethics Review Committee and Ho Teaching Hospital Ethics Review Committee (Protocol ID NO**: HTH-REC (26) FC_2024**). The research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Availability of data and materials

The data used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no conflict of interest.

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Authors' contributions

All authors contributed substantially to the conception, design, data collection, analysis, and writing of the manuscript. All authors have read and approved the final version.

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Figures

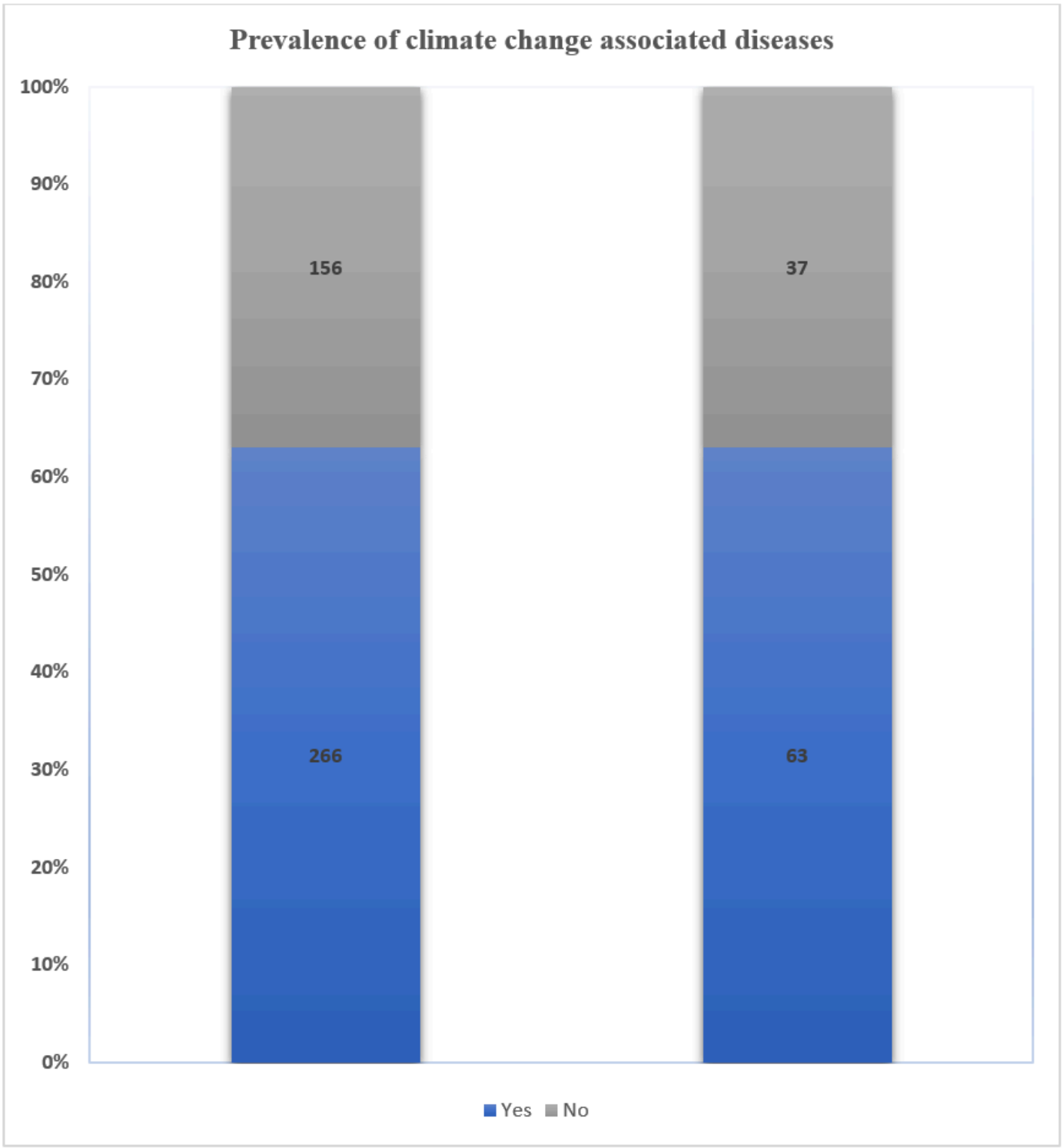

Figure 1

Prevalence of climate change-associated diseases

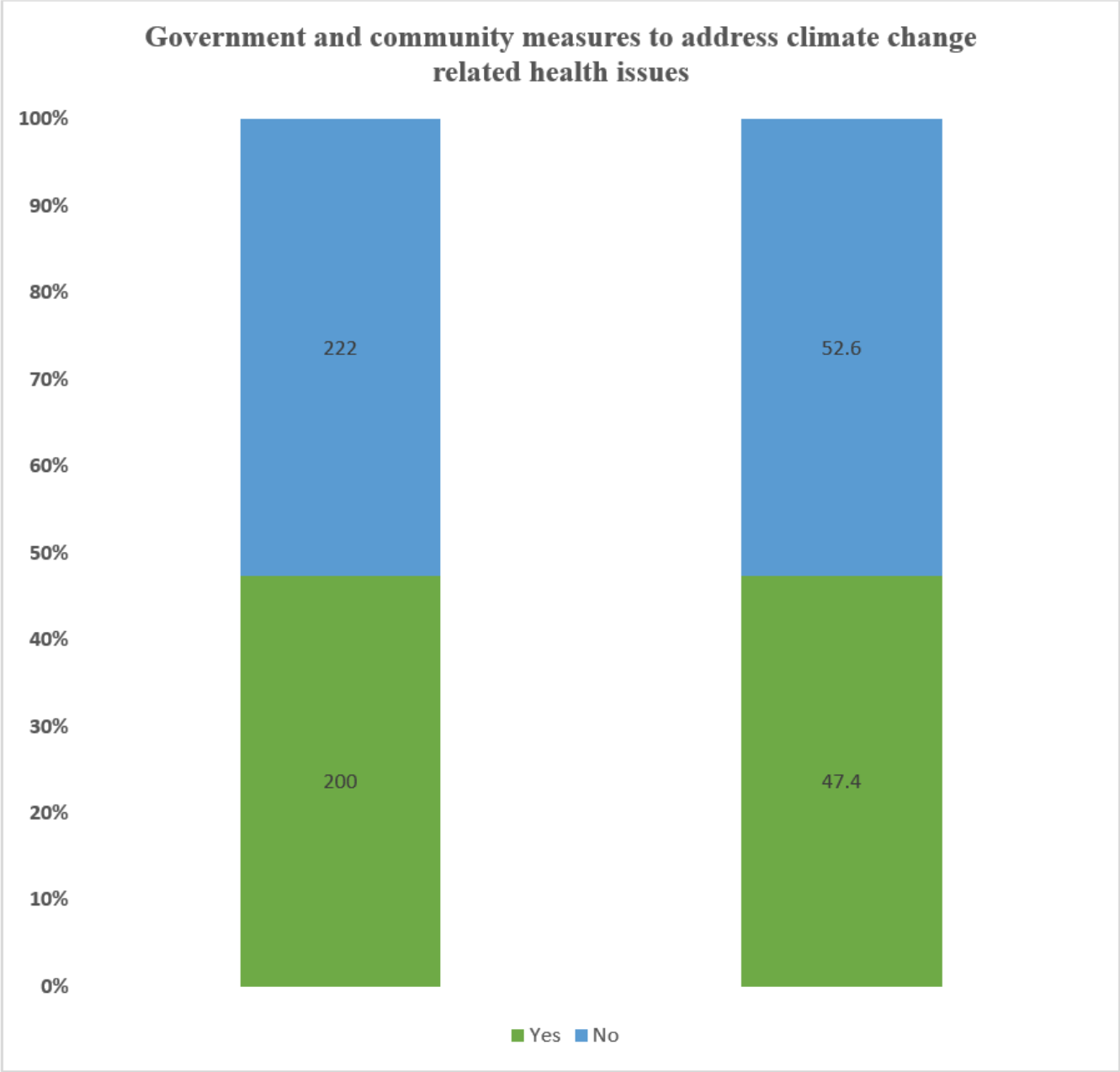

Figure 2

Government and community measures to address climate change-related health issues

Supplementary Files

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