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Climate Change and Public Health in Bangladesh: Perceptions, Vulnerabilities, and Empirical Evidence from Coastal Communities

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Abstract: Coastal communities in Bangladesh are increasingly vulnerable to the impacts of climate change. These effects worsen health issues and hinder access to essential healthcare services. This study explores the challenges these communities face in climate change awareness, health outcomes, and healthcare access. It focuses on gender disparities, climate-induced disasters, and healthcare infrastructure. The study used a mixed-methods approach, combining quantitative surveys and qualitative interviews with coastal residents from Banshkhali and Kutubdia sub-districts. It assessed their perceptions of climate change, its health impacts, and healthcare access. Statistical analyses, including Chi-square tests and p-values, revealed significant relationships between climate-induced disasters, such as floods, cyclones, and sea-level rise, and health problems. These include respiratory disorders, mosquito-borne diseases, and mental health issues. The study also highlighted gender disparities in climate change awareness. Men were more informed due to their outdoor occupations. Women faced barriers to information access because of restricted mobility and limited communication channels. The study identified critical gaps in disaster management services and awareness of the Bangladesh Health Policy 2011. These gaps further intensified vulnerabilities. Despite modern healthcare options, 14% of residents still relied on indigenous treatments. This highlights the need for an integrated healthcare approach. The study concludes with recommendations for gender-sensitive climate communication, integrating indigenous knowledge with modern healthcare, strengthening disaster preparedness, and raising awareness of health policies. These strategies are crucial for enhancing climate resilience and ensuring equitable healthcare for coastal communities facing the dual challenges of climate change and health disparities.

Keywords: *Climate Change, Healthcare Access, Coastal Communities, Gender Disparities, Indigenous Knowledge*

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1. Introduction

Climate change has emerged as one of the most pressing global health challenges of the 21st century, fundamentally altering the environmental determinants of human health worldwide (McMichael et al., 2020; McGirr et al., 2025). It affects health through direct mechanisms, such as heat-related illnesses, injuries from extreme weather events, and respiratory problems linked to air pollution, and indirect pathways including poor water quality, food insecurity, vector-borne diseases, and mental health impacts shaped by social inequities (McMichael et al., 2020; Giri et al., 2023). Recent studies have further identified indoor environmental conditions as a critical yet underexplored pathway linking ambient climate change to population health, particularly in low-income settings with inadequate housing infrastructure (Akter et al., 2025). Bangladesh exemplifies a country facing severe climate vulnerability despite contributing minimally to global greenhouse gas emissions. Its deltaic geography, low-lying terrain, dense river networks, and extensive coastline expose millions to rising temperatures, sea-level rise, and increasing extreme weather events

(Hossain, 2025). Spatial assessments reveal that the southern coastal districts, including Banshkhali and Kutubdia, face heightened risks of cyclones, floods, and salinity intrusion (Imam et al., 2024). Hydrological projections warn of increasing rainfall variability, intensified monsoon flows, and altered river regimes, all of which threaten water supply and sanitation systems (Rahaman et al., 2025). Meanwhile, coastal morphological changes persist, causing erosion, habitat loss, and displacement (Saddam et al., 2025).

Coastal communities in Bangladesh experience a convergence of climate-sensitive health burdens, limited access to healthcare, and livelihood disruptions (Kabir et al., 2025). Malnutrition, diarrheal and respiratory infections, vector-borne diseases, hypertension, and mental health disorders rise seasonally with extreme weather events. Livelihood disruptions from salinity, flooding, and crop loss further exacerbate health risks (Jui et al., 2025). Gender-specific vulnerabilities remain pronounced, with salinity intrusion and extreme heat negatively affecting maternal and reproductive health outcomes (Amin et al., 2025). Community perceptions of climate–health linkages vary by livelihood patterns and resource access (Zakaria et al., 2025), while migration emerges as a key adaptive strategy among the poorest households (Clech et al., 2024). Fishing and farming groups face layered vulnerabilities shaped by social, ecological systems and governance structures (Barua et al., 2020; Sultana et al., 2023). Despite growing evidence, major research gaps remain in understanding the mechanisms linking climate exposure, health outcomes, vulnerability, and local perceptions (Sumon et al., 2025; Lilier et al., 2025). To address these gaps, the present study examines the complex relationships between climate change exposure, public health outcomes, and community perceptions in coastal Bangladesh. Using a mixed-methods approach that combines quantitative health assessments with qualitative exploration of community experiences, the study seeks to provide empirical evidence to inform targeted, community-informed climate–health interventions. In addition to the central aim, this research was guided by the following research question and hypotheses: Research Question: How do coastal residents perceive the linkages between climate change and their health conditions? Hypothesis (H0): There is no relation between climate change-induced disasters (CCIDs) and health problems or diseases of coastal residents. The overall findings of this research contribute to the expanding literature on climate–health interactions and offer actionable insights for public health practitioners, policymakers, and community organisations working to enhance resilience in climate-vulnerable coastal settings.

2. Materials and methods

2.1. Research Design

This study employed a cross-sectional mixed methods design to investigate the impacts of climate change on the health of coastal communities in southeastern Bangladesh. Both quantitative and qualitative approaches were used, drawing on primary and secondary data sources. Primary data collection involved questionnaire surveys (n=384), Focus Group Discussions (FGDs, n=6), Key Informant Interviews (KIIs, n=10), and participant observation. The study population was selected purposively, focusing on vulnerable age groups (women aged 45–55 years and men aged 55–75 years), who are more susceptible to climate-sensitive health risks but also possess valuable indigenous knowledge of resilience practices. Two highly climate-vulnerable coastal upazilas, Banshkhali in Chattogram district and Kutubdia in Cox's Bazar district, were selected as study sites due to their recurrent exposure to cyclones, sea-level rise, and salinity intrusion. To determine the survey sample size, Cochran's formula (Islam, 2014) was applied.

Formula,

$$\text{With } n_0 = \frac{p\,(1\text{-}p)\,Z^2}{d^2}$$

Where n0 is denoted desired sample size, p is the proportion of the required characteristics in the population. Theoretically, when p is unknown, p=0.5 gives the safest sample size since p (1-p) takes the highest value for p=0.5, Z^2 the value of the standard normal deviate is usually set at 1.96 out of a 95% confidence level, and d is the allowed margin of error. A proportional random sampling technique was further used to distribute the calculated sample size across unions within the study area.

Additionally, the Chi-square test (χ^2) was applied to examine associations between climate variables (temperature, precipitation) and reported health impacts, using the formula.

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Where O - represents observed frequencies and E - expected frequencies. This analytical approach facilitated hypothesis testing regarding the relationship between climate variability and community health outcomes.

Data analysis combined both statistical, especially inferential statistics, and narrative techniques. Quantitative data were coded and analyzed using SPSS (v.25), applying descriptive statistics and chi-square tests to identify patterns and associations. Qualitative data from FGDs, KIIs,

and observations were transcribed, coded thematically, and interpreted through narrative analysis, enabling triangulation of findings. Secondary data, including government reports, academic studies, and NGO documents, were utilized to contextualize the primary findings and enhance validity. Ethical considerations were rigorously maintained by obtaining informed consent and ensuring confidentiality throughout the research process.

3. Results

3.1. People's Perception of Climate Change by Gender

Nearly 65.1% of coastal people reported awareness of climate change, while 34.9% were unaware of the concept (Table 1). A statistically significant association was observed between gender and perception levels ($p = 0.002$), suggesting that men and women experience and interpret climate information differently. This disparity is likely influenced by differences in educational attainment, livelihood engagement, and social participation. Men, who are often more involved in outdoor occupations such as fishing or farming, may have greater exposure to environmental information and early warning systems. In contrast, women's limited mobility and restricted access to formal communication channels can reduce their opportunity to receive or interpret climate-related messages.

Table 1: People's Perception of Climate Change by Gender

	Frequency	Percentage	P -value
Yes	250	65.1	
No	134	34.9	**0.002**
Total	384	100.0	

Although national and local media extensively cover climate change issues, these communication efforts often fail to reach remote coastal settlements. The study areas, characterised by dispersed households, inadequate infrastructure, and poverty, remain poorly served by community radio or local awareness programs. Consequently, many marginalised households, particularly female-headed ones, lack access to reliable information about climate risks and adaptation measures. This situation shows the need for gender-sensitive communication that uses local languages, informal networks, and community organizations to improve climate awareness and strengthen resilience in coastal Bangladesh.

3.2. Types of Disasters Attributed to Climate Change

The research identified 12 types of recurring climate-change-induced disasters across the coastal upazilas of Banshkhali and Kutubdia (Table 2). Among these, thunderstorms (12.9%), changes in seasonal rainfall patterns (11.3%), and sea-level rise (10.0%) were the most frequently reported hazards. In Banshkhali, the dominant events included thunderstorms (13%), storm surges (12%), irregular rainfall (11%), sea-level rise (11%), and extreme heat (10%). Conversely, in Kutubdia, the most recurrent hazards were thunderstorms (13%), irregular rainfall (12%), tidal water intrusion (12%), waterborne diseases (11%), and bank erosion (10%). These variations reflect the influence of geomorphological settings, where Banshkhali's low-lying riverine terrain experiences hydrological interactions between tidal flows and upstream runoff, while Kutubdia's island geography exposes it to coastal inundation and erosion linked to rising sea levels

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Table 2: Types of disasters that have occurred in your area due to climate change

	Upazila				Total	
	Banshkhali		Kutubdia			
	f	*%*	*f*	*%*	*f*	*%*
Flood	9	0.6	3	0.3	12	0.5
Cyclone	123	7.7	2	0.2	125	4.9
Storm Surge	189	11.8	26	2.7	215	8.4
Bank Erosion	39	2.4	100	10.5	139	5.4
Increase in salinity or salinization	114	7.1	77	8.1	191	7.5
Increase in temperature (extreme heat)	155	9.7	65	6.8	220	8.6
Intrusion of tidal water	126	7.9	116	12.2	242	9.5
Change in the seasonal pattern of rainfall	170	10.6	119	12.5	289	11.3
Rise in sea level	177	11.0	77	8.1	254	10.0
Thunderstorms	202	12.6	128	13.5	330	12.9
Fever (Kalajjar)	158	9.9	129	13.6	287	11.3
Waterborne diseases	140	8.7	108	11.4	248	9.7
Total	**1602**	**100.0**	**950**	**100.0**	**2552**	**100.0**

N.B: Multiple Answer Considered

Qualitative findings corroborate these patterns, highlighting a combination of slow-onset and sudden-onset disasters shaping community vulnerability. Slow-onset events include salinity intrusion, sea-level rise, drought, and changes in temperature and precipitation patterns, while sudden-onset hazards, such as cyclones, floods, bank erosion, and thunderstorms, occur with increasing frequency and intensity. Local participants emphasized that the absence of protective embankments, the synchronization of tidal surges with riverine inflows, and the region's flat topography exacerbate flood exposure and soil degradation. The findings further advocate that the social and livelihood structure of coastal households mediates their disaster experiences. Households dependent on agriculture, aquaculture, and fishing reported higher sensitivity to salinity intrusion and rainfall irregularities,

directly affecting productivity and income. Education and gender dynamics also influence disaster awareness and preparedness: men engaged in outdoor labor tend to recognize environmental signals earlier, whereas women, who manage domestic and water collection duties, face heightened exposure to waterborne and heat-related health risks. Collectively, these findings show that climate vulnerability in coastal Bangladesh depends on environmental stress, social inequality, and gender-based livelihood roles.

3.3. Recurrence of Climate Change Induced Disasters

A clear perception among coastal residents of an increasing frequency of climate change-induced disasters in recent years (Figure 1). A vast majority of respondents (92%) reported that disaster occurrences have either "greatly increased" (45%) or "increased further" (47%) over time, while only a small minority perceived no significant change. These perceptions align with long-term climate data and regional observations that show heightened intensity and recurrence of extreme weather events, including cyclones, tidal surges, and erratic rainfall patterns in coastal Bangladesh.

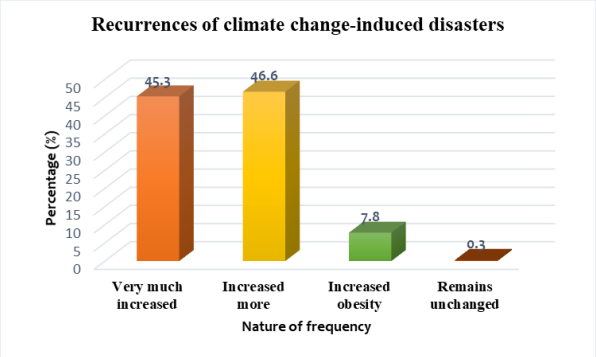

Figure 1: Recurrence of Climate Climate Change-Induced Disasters

Moreover, local communities interpret the growing recurrence of hazards as evidence of climatic instability and environmental degradation. Residents associate these changes with disrupted agricultural cycles, declining fish yields, and increased salinity intrusion, factors that directly threaten food security and livelihoods. The convergence of empirical observation and community perception underscores an important adaptive awareness among coastal populations, highlighting the need for sustained, localized monitoring systems and community-based disaster risk reduction strategies.

3.4. Extent of Climate Change (Temperature Variation) and Human Health Impacts

The perception of temperature variation was examined as one of the key indicators of climate change and its influence on human health using a five-point Likert scale (Table 3). Findings reveal that almost all respondents (99%) perceived a noticeable change in temperature conditions over recent years. Among them, 51.6% described the change as "very undesirable", and 47.1% labeled it "unwanted", suggesting an overwhelmingly negative perception of temperature-related changes. Only a negligible fraction (1.3%) viewed the change as neutral or favorable.

Table 3: Extent of Climate Change (Temperature Variation) and Human Health Impacts

	Frequency	**Percent**	P-value
Very undesirable	198	51.6	
Unwanted	181	47.1	
Neutral (not quite)	1	.3	0.000
Very desirable/good	4	1.0	
Total	384	100.0	

The p-value ($p = 0.000$) indicates a statistically significant association between perceived temperature variation and reported human health impacts. This strong significance level (< 0.05) implies that rising temperature conditions are not random observations but are closely correlated with health outcomes in the study areas. Respondents frequently link higher temperatures to increased incidence of heat-related illnesses, dehydration, vector-borne diseases, and general discomfort, particularly among outdoor workers and the elderly. These results are consistent with global evidence highlighting the direct and indirect health consequences of rising temperatures, such as those reported by McMichael et al. (2020) and Rahman & Rahman (2023), where sustained heat stress amplifies cardiovascular and respiratory risks. The findings underscore that temperature variation functions as both a climatic and public health stressor, disproportionately affecting low-income coastal populations who lack adequate housing, cooling facilities, and healthcare access. Hence, the statistically significant relationship ($p = 0.000$) underscores the urgent need for climate-sensitive health interventions and adaptive infrastructure in Bangladesh's coastal regions.

3.5. Extent of Climate Change (Precipitation Variation) and Human Health Impacts

The perception of precipitation variation was analyzed as a critical climatic factor influencing health outcomes in coastal Bangladesh. Using a five-point Likert scale (Table 4), nearly all respondents (97%) reported that precipitation conditions have changed unfavorably in recent years. Among them, 52.3% rated the change as "very undesirable", and 44.5% as "unwanted", indicating widespread concern about altered rainfall patterns. Only a negligible 3% considered the change neutral or desirable, underscoring the community's overwhelming perception of adverse climatic shifts.

Table 4: Extent of Climate Change (Precipitation Variation) and Human Health Impacts

	Frequency	Percent	P-value
Very undesirable	201	52.3	
Unwanted	171	44.5	
Neutral (not quite)	6	1.6	0.000
Desirable (desired)	2	.5	
Very desirable/good	4	1.0	
Total	384	100.0	

The statistical test yielded a p-value of 0.000, demonstrating a highly significant relationship between changes in precipitation patterns and perceived human health impacts. This strong significance level ($p < 0.05$) confirms that the observed association is not due to random variation. It implies that irregular or extreme rainfall events, such as prolonged dry spells followed by intense rainfall, have direct and indirect consequences on health, including increased risks of waterborne diseases, vector proliferation, and mental stress from recurrent flooding. In addition, narratives from field participants further support these results, revealing that erratic precipitation has disrupted agricultural production cycles, damaged sanitation infrastructure, and heightened disease outbreaks. These outcomes align with global and regional research demonstrating how climate-induced rainfall variability affects both communicable disease patterns and food security (Rahman & Rahman, 2023; McMichael et al., 2020). The statistically significant ($p = 0.000$) result thus underscores the urgent need for integrated adaptation strategies that combine water management, public health preparedness, and community awareness to mitigate the cascading health impacts of precipitation variability in coastal Bangladesh.

3.6. Perception of Climate Change as a Cause of Health Problems

The data presented in Table 5 indicates that 100% of respondents agreed that climate change is responsible for health problems, with no opposition recorded. The p-value of 0.000 is statistically significant, suggesting that the observed result is highly unlikely to be due to chance. In scientific research, a p-value of less than 0.05 indicates strong evidence against the null hypothesis, supporting the conclusion that people's perceptions of climate change as a health risk are significant. In this reality, this result highlights that climate change is widely seen as a serious public health concern directly linked to negative health outcomes.

Table 5: Perception of Climate Change as a Cause of Health Problems

	Frequency	Percentage	P-value
Yes	384	100.0	
No	00	00.0	0.000
Total	384	100.0	

3.7. Prevalence of Climate Change-Induced Health Issues among Coastal Residents

Almost 28 sorts of health conditions are prevalent among coastal residents, with a higher number of responses recorded in Banshkhali (5197 responses) compared to Kutubdia (3288 responses), suggesting greater vulnerability in Banshkhali (Table 6). Qualitative analysis highlights that climate change-induced health issues, such as uterine disease, high blood pressure, respiratory disorders, mosquito-borne diseases (dengue), mental health problems, and outbreaks of diarrhea and cholera, are commonly reported in both regions. These diseases, associated with environmental stressors like extreme temperatures, floods, and changing disease patterns, are compounded by inadequate healthcare access, particularly in Banshkhali. The p-values, likely indicating statistical significance ($p < 0.05$), suggest a strong relationship between these health problems and climate change, reinforcing the argument that climate-induced health risks are particularly severe in vulnerable coastal areas. Eventually, the findings highlight the need for focused health programs and climate adaptation policies to protect these vulnerable communities.

Table 6: Prevalence of Climate Change-Induced Health Issues Among Coastal Residents

	Upazila	Total

	Banshkhali		Kutubdia			
	f	*%*	*f*	*%*	*F*	*%*
1. Uterine disease	200	3.8	79	2.4	279	3.3
2. High blood pressure	202	3.9	127	3.9	329	3.9
3. Gestational convulsions	216	4.2	102	3.1	318	3.7
4. Miscarriage	196	3.8	107	3.3	303	3.6
5. Premature birth/ fetus	201	3.9	107	3.3	308	3.6
6. Respiratory disorders	204	3.9	155	4.7	359	4.2
7. Mosquito-borne diseases	56	1.1	50	1.5	106	1.2
8. Mental health	170	3.3	122	3.7	292	3.4
9. Dengue outbreaks	210	4.0	154	4.7	364	4.3
10. Anxiety/depression levels increase	211	4.1	141	4.3	352	4.1
11. Mass Psychosis Illness	155	3.0	122	3.7	277	3.3
12. Abdominal Aches	193	3.7	149	4.5	342	4.0
13. Scabies or Skin Diseases or Allergies	22	0.4	14	0.4	36	0.4
14. Shortness of breath	178	3.4	87	2.6	265	3.1
15. Heat Stroke	209	4.0	152	4.6	361	4.3
16. Death due to acute cold	210	4.0	127	3.9	337	4.0
17. Diarrhea outbreaks	187	3.6	71	2.2	258	3.0
18. Outbreak of cholera	216	4.2	153	4.7	369	4.3
19. High Blood Pressure	219	4.2	146	4.4	365	4.3
20. Pre-eclampsia	221	4.3	148	4.5	369	4.3
21. Malaria prevalence will increase	224	4.3	121	3.7	345	4.1
22. Trachoma- Trachoma due to lack of clean water – Trachoma causes blindness	225	4.3	155	4.7	380	4.5
23. Asthma	209	4.0	149	4.5	358	4.2
24. Malnutrition	133	2.6	91	2.8	224	2.6
25. Fever and Headaches	100	1.9	117	3.6	217	2.6
26. Jaundice	213	4.1	129	3.9	342	4.0
27. Diabetes	210	4.0	113	3.4	323	3.8
28. Pneumonia	207	4.0	100	3.0	307	3.6
Total	5197	100.0	3288	100.0	8485	100.0

N.B: Multiple Answer Considered.

3.8. Relationship between climate change-induced disasters (CCIDs) and health problems or diseases

Based on the Chi-square test, the Tab value is greater than the Cal value, indicating that the result is statistically significant (Tab value > Cal value). Additionally, the p-value is less than or equal to 0.01, further confirming the significance of the findings. As a result, the null hypothesis is rejected, and the alternative hypothesis is supported, suggesting a significant and positive correlation between climate change-induced disasters and health problems or diseases.

Table 7: Relationship between climate change-induced disasters (CCIDs) and health problems or diseases

1st Variable	2nd Variable	Chi-square (χ^2) Cal value	Tab value	Result	df	*P - value*
Flood	Mosquito-borne diseases	9.46	3.841	5.6	1	0.002
	Diarrhea outbreaks	10.00	3.841	6.2	1	0.002
	Uterine disease	6.19	3.841	2.3	1	0.013
	Gestational convulsions	9.16	3.841	5.3	1	0.002
	Premature birth/ fetus	4.47	3.841	0.6	1	0.034
	Respiratory disorders	15.30	3.841	11.5	1	0.000
	Mental health	14.55	3.841	10.7	1	0.000
	Abdominal Ache	12.98	3.841	9.1	1	0.000
Cyclone	Shortness of breath	10.47	3.841	6.6	1	0.001
	Diarrhea outbreaks	36.41	3.841	32.6	1	0.000
	Outbreak of cholera	7.53	3.841	3.7	1	0.006
	Malaria prevalence will increase	17.78	3.841	13.9	1	0.000
	Asthma	3.87	3.841	0.0	1	0.049
	Malnutrition	8.35	3.841	4.5	1	0.004
	Diabetes	12.48	3.841	8.6	1	0.000

1st Variable	2nd Variable	Chi-square (χ^2) Cal value	Tab value	Result	df	*P - value*
	Pneumonia	42.85	3.841	39.0	1	0.000
	Uterine disease	8.70	3.841	4.9	1	0.000
	Gestational convulsions	14.46	3.841	10.6	1	0.000
	Premature birth/ fetus	6.07	3.841	2.2	1	0.014
	Respiratory disorders	11.12	3.841	7.3	1	0.001
	Mosquito-borne diseases	7.18	3.841	3.3	1	0.007
	Mass Psychosis Illness	5.35	3.841	1.5	1	0.021
	Abdominal Ache	4.56	3.841	0.7	1	0.033
	Shortness of breath	13.66	3.841	9.8	1	0.000
Storm Surge	Heat Stroke	7.03	3.841	3.2	1	0.008
	Death due to acute cold	12.59	3.841	8.7	1	0.000
	Diarrhea outbreaks	60.57	3.841	56.7	1	0.000
	Outbreak of cholera	5.44	3.841	1.6	1	0.020
	Malaria prevalence will increase	50.28	3.841	46.4	1	0.000
	Malnutrition	7.82	3.841	4.0	1	0.005
	Fever and Headaches	30.19	3.841	26.3	1	0.000
	Diabetes	4.08	3.841	0.2		0.044
	Pneumonia	11.33	3.841	7.5	1	0.001
	Miscarriage	5.88	3.841	2.0	1	0.015
	Respiratory disorders	15.17	3.841	11.3	1	0.000
	Mosquito-borne diseases	7.29	3.841	3.4	1	0.007
	Mass Psychosis Illness	5.31	3.841	1.5	1	0.021
	Scabies or Skin Diseases or Allergies	8.56	3.841	4.7	1	0.003
	Shortness of breath	13.37	3.841	9.5	1	0.000
	Heat Stroke	5.67	3.841	1.8	1	0.017
Bank	Death due to acute cold	17.70	3.841	13.9	1	0.000
Erosion	Diarrhea outbreaks	67.73	3.841	63.9	1	0.000
	Outbreak of cholera	6.12	3.841	2.3	1	0.012
	Malaria prevalence will increase	20.50	3.841	16.7	1	0.000
	Malnutrition	7.74	3.841	3.9	1	0.005
	Fever and Headaches	8.30	3.841	4.5	1	0.004
	Jaundice	18.95	3.841	15.1	1	0.000
	Diabetes	18.78	3.841	14.9	1	0.000
	Pneumonia	44.41	3.841	40.6	1	0.000
	Miscarriage	3.9	3.841	0.1	1	0.003
	Premature birth/ fetus	3.89	3.841	0.0	1	0.013
	Mosquito-borne diseases	38.78	3.841	34.9	1	0.000
	Mental health	73.12	3.841	69.3	1	0.000
	Anxiety/depression levels increase	10.82	3.841	7.0	1	0.001
	Mass Psychosis Illness	88.06	3.841	84.2	1	0.000
	Scabies or Skin Diseases or Allergies	6.17	3.841	2.3	1	0.013
Increase in	Shortness of breath	16.11	3.841	12.3	1	0.000
salinity or	Pre-eclampsia	11.58	3.841	7.7	1	0.001
salinizatio	Malaria prevalence will increase	4.97	3.841	1.1	1	0.026
n	Trachoma- Trachoma due to lack of clean water –	4.08	3.841		1	0.043
	Trachoma causes blindness			0.2		
	Asthma	4.01	3.841	0.2	1	0.045
	Malnutrition	51.25	3.841	47.4	1	0.000
	Fever and Headaches	43.58	3.841	39.7	1	0.000
	Jaundice	20.63	3.841	16.8	1	0.000
	Diabetes	20.81	3.841	17.0	1	0.000
	Pneumonia	41.59	3.841	37.7	1	0.000
Increase in	Gestational convulsions	7.2	3.841	3.4	1	0.007
temperatu	Premature birth/ fetus	18.34	3.841	14.5	1	0.000
re	Respiratory disorders	3.82	3.841	0.0	1	0.050
(extreme	Mosquito-borne diseases	10.84	3.841	7.0	1	0.001
heat)	Mental health	87.53	3.841	83.7	1	0.000

1st Variable	2nd Variable	Chi-square (χ^2)				
		Cal value	Tab value	Result	df	*P - value*
	Anxiety/depression levels increase	9.67	3.841	5.8	1	0.002
	Mass Psychosis Illness	62.30	3.841	58.5	1	0.000
	Scabies or Skin Diseases or Allergies	3.8	3.841	0.0	1	0.030
	Shortness of breath	5.15	3.841	1.3	1	0.023
	Outbreak of cholera	5.50	3.841	1.7	1	0.019
	Pre-eclampsia	20.94	3.841	17.1	1	0.000
	Malnutrition	62.12	3.841	58.3	1	0.000
	Fever and Headaches	20.34	3.841	16.5	1	0.000
	Jaundice	4.00	3.841	0.2	1	0.045
	Diabetes	17.79	3.841	13.9	1	0.000
	Pneumonia	38.60	3.841	34.8	1	0.000
	Gestational convulsions	12.08	3.841	8.2	1	0.001
	Miscarriage	4.24	3.841	0.4	1	0.039
	Respiratory disorders	14.07	3.841	10.2	1	0.000
	Mosquito-borne diseases	22.81	3.841	19.0	1	0.000
	Mental health	70.81	3.841	67.0	1	0.000
	Anxiety / depression levels increase	29.35	3.841	25.5	1	0.000
	Mass Psychosis Illness	54.92	3.841	51.1	1	0.000
Intrusion of tidal water	Abdominal Ache	8.22	3.841	4.4	1	0.004
	Scabies or Skin Diseases or Allergies	7.03	3.841	3.2	1	0.008
	Diarrhea outbreaks	15.69	3.841	11.8	1	0.000
	Pre-eclampsia	12.39	3.841	8.5	1	0.000
	Malaria prevalence will increase	13.30	3.841	9.5	1	0.000
	Asthma	15.59	3.841	11.7	1	0.000
	Malnutrition	23.97	3.841	20.1	1	0.000
	Fever and Headaches	56.48	3.841	52.6	1	0.000
	Premature birth/ fetus	29.17	3.841	25.3	1	0.000
	Mosquito-borne diseases	34.56	3.841	30.7	1	0.000
	Mental health	157.12	3.841	153.3	1	0.000
	Anxiety/depression levels increase	27.63	3.841	23.8	1	0.000
	Mass Psychosis Illness	131.84	3.841	128.0	1	0.000
	Abdominal Ache	8.31	3.841	4.5	1	0.004
Change in	Scabies or Skin Diseases or Allergies	3.96	3.841	0.1	1	0.047
the	Death due to an acute cold	9.69	3.841	5.8	1	0.002
seasonal	Diarrhea outbreaks	9.39	3.841	5.5	1	0.002
pattern of	Pre-eclampsia	39.44	3.841	35.6	1	0.000
rainfall	Malaria prevalence will increase	6.77	3.841	2.9	1	0.009
	Asthma	12.69	3.841	8.8	1	0.000
	Malnutrition	84.92	3.841	81.1	1	0.000
	Fever and Headaches	94.20	3.841	90.4	1	0.000
	Jaundice	4.51	3.841	0.7	1	0.034
	Diabetes	8.30	3.841	4.5	1	0.004
	Pneumonia	25.06	3.841	21.2	1	0.000
	Uterine disease	9.21	3.841	5.4	1	0.002
	Gestational convulsions	7.13	3.841	3.3	1	0.008
	Miscarriage	14.53	3.841	10.7	1	0.000
	Respiratory disorders	13.68	3.841	9.8	1	0.000
	Mosquito-borne diseases	30.47	3.841	26.6	1	0.000
	Mental health	25.16	3.841	21.3	1	0.000
Rise in sea	Mass Psychosis Illness	18.28	3.841	14.4	1	0.000
level	Scabies or Skin Diseases or Allergies	11.55	3.841	7.7	1	0.002
	Shortness of breath	15.19	3.841	11.3	1	0.000
	Death due to an acute cold	11.01	3.841	7.2	1	0.001
	Diarrhea outbreaks	31.26	3.841	27.4	1	0.000
	Pre-eclampsia	4.76	3.841	0.9	1	0.029
	Malaria prevalence will increase	4.29	3.841	0.4	1	0.039
	Fever and Headaches	19.81	3.841	16.0	1	0.000

1st Variable	2nd Variable	Chi-square (χ^2)				
		Cal value	Tab value	Result	df	*P - value*
Thunderstorms	Jaundice	29.73	3.841	25.9	1	0.000
	Diabetes	20.50	3.841	16.7	1	0.000
	Pneumonia	69.40	3.841	65.6	1	0.000
	Mosquito-borne diseases	5.13	3.841	1.3	1	0.023
	Mental health	68.48	3.841	64.6	1	0.000
	Dengue outbreaks	4.43	3.841	0.6	1	0.035
	Anxiety/depression levels increase	8.53	3.841	4.7	1	0.003
	Mass Psychosis Illness	42.68	3.841	38.8	1	0.000
	Scabies or Skin Diseases or Allergies	4.18	3.841	0.3	1	0.041
	Death due to an acute cold	6.31	3.841	2.5	1	0.012
	Pre-eclampsia	13.73	3.841	9.9	1	0.000
	Malaria prevalence will increase	7.10	3.841	3.3	1	0.008
	Asthma	6.44	3.841	2.6	1	0.011
	Malnutrition	13.85	3.841	10.0	1	0.000
	Fever and Headaches	40.49	3.841	36.6	1	0.000
Fever (Kalajjar)	Diabetes	11.43	3.841	7.6	1	0.001
	Pneumonia	19.91	3.841	16.1	1	0.000
	Uterine disease	5.04	3.841	1.2	1	0.025
	Gestational convulsions	7.28	3.841	3.4	1	0.007
	Respiratory disorders	17.09	3.841	13.2	1	0.000
	Mosquito borne diseases	13.09	3.841	9.2	1	0.000
	Mental health	102.31	3.841	98.5	1	0.000
	Anxiety / depression levels increase	13.31	3.841	9.5	1	0.001
	Mass Psychosis Illness	98.94	3.841	95.1	1	0.000
	Death due to acute cold	7.95	3.841	4.1	1	0.005
	Diarrhea outbreaks	17.71	3.841	13.9	1	0.000
	Pre-eclampsia	19.10	3.841	15.3	1	0.000
	Malaria prevalence will increase	9.31	3.841	5.5	1	0.002
	Asthma	15.53	3.841	11.7	1	0.000
	Malnutrition	60.25	3.841	56.4	1	0.000
	Fever and Headaches	68.03	3.841	64.2	1	0.000
Waterborne diseases	Jaundice	4.11	3.841	0.3	1	0.043
	Diabetes	9.49	3.841	5.6	1	0.002
	Pneumonia	15.79	3.841	11.9	1	0.000
	Uterine disease	4.83	3.841	1.0	1	0.028
	Gestational convulsions	7.03	3.841	3.2	1	0.008
	Premature birth/ fetus	4.68	3.841	0.8	1	0.030
	Mosquito borne diseases	17.53	3.841	13.7	1	0.000
	Mental health	128.90	3.841	125.1	1	0.000
	Anxiety / depression levels increase	27.83	3.841	24.0	1	0.000
	Mass Psychosis Illness	82.24	3.841	78.4	1	0.000
	Death due to acute cold	4.68	3.841	0.8	1	0.030
	Diarrhea outbreaks	12.60	3.841	8.8	1	0.000
	Outbreak of cholera	5.64	3.841	1.8	1	0.018
	Pre-eclampsia	28.46	3.841	24.6	1	0.000
	Malaria prevalence will increase	9.69	3.841	5.8	1	0.000
	Malnutrition	58.48	3.841	54.6	1	0.000
	Fever and Headaches	85.07	3.841	81.2	1	0.000
	Jaundice	4.38	3.841	0.5	1	0.036
	Diabetes	15.29	3.841	11.4	1	0.000
	Pneumonia	39.98	3.841	36.1	1	0.000

Source: Compiled by author, 2023

The Chi-square test results reveal significant relationships between various climate change-induced disasters (CCIDs) and health problems in the study areas. Extreme weather events such as floods, cyclones, storm surges, and rising sea levels are strongly correlated with health issues like respiratory disorders, mosquito-borne diseases, mental health problems, and malnutrition. The p-values for most correlations are below 0.05, with many reaching a level of significance at $p \leq 0.001$, confirming the

strong association between CCIDs and health outcomes. Notable findings include a p-value of 0.000 for respiratory disorders and pneumonia, indicating a critical impact of climate change on respiratory health. A crosstabulation analysis identified that two diseases are linked to floods, fourteen diseases are associated with cyclones and thunderstorms, and seventeen diseases are related to storm surges, salinity increases, changes in rainfall patterns, sea-level rise, fever (Kalajjar), and waterborne diseases. Sixteen diseases are connected to bank erosion and extreme heat, while fifteen diseases are associated with tidal water intrusion. The crosstabulation reveals five disease clusters based on their correlation with specific disasters.

The qualitative findings of this study highlight the severe impact of climate change-induced disasters (CCIDs) on coastal populations, exacerbating various health issues. Coastal communities face numerous challenges due to recurrent extreme weather events, such as floods, cyclones, storm surges, and rising sea levels, which are linked to a range of health problems. For example, respiratory disorders, mosquito-borne diseases, mental health issues, and malnutrition are closely associated with these climate events. The recurrent nature of these disasters creates a cycle of health risks, where marginalized populations, already struggling with poverty, lack of infrastructure, and poor access to healthcare, are left vulnerable. Flooding, for instance, has been linked to the spread of waterborne diseases, while the increase in temperature and salinity is contributing to a rise in skin diseases, respiratory problems, and mental health disorders like anxiety and depression. Additionally, the salinization of freshwater sources forces communities to rely on unsafe water, further increasing the incidence of diseases like cholera and diarrhea. The cumulative effect of these disasters is particularly detrimental to vulnerable groups, such as pregnant women, children, and the elderly, who are more susceptible to conditions like miscarriage, premature birth, and heat stroke. The p-values indicate a strong statistical significance in the relationship between these disasters and the health outcomes, highlighting the urgent need for comprehensive climate adaptation strategies to mitigate the health impacts in these communities.

3.9. People have followed local (indigenous) treatment methods

About 14% of coastal residents still rely on local (indigenous) treatment methods when they fall ill (Figure 2). This suggests that, despite the availability of modern healthcare, traditional healing practices continue to play a significant role in the community's approach to health. The reliance on indigenous treatments may stem from factors such as limited access to formal healthcare, cultural beliefs, or the affordability and familiarity of traditional remedies. This outcome highlights the need to combine local knowledge with modern healthcare to better meet the health needs of coastal populations.

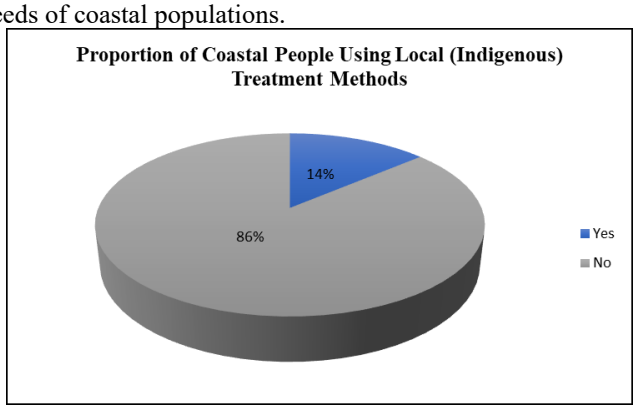

Figure 2: Proportion of Coastal People Using Local (Indigenous) Treatment Methods

A significant portion of the coastal population (86.2%) does not rely on indigenous treatments (Table 10). However, for those who do, 6.7% use medicinal tree leaves, 3.3% use Arjun tree skin and leaves along with Neem leaves, and 3.6% seek treatment from Kobiraji practitioners. These findings highlight that while traditional remedies are still prevalent, they are used by a smaller fraction of the population. The continued use of indigenous treatments may be due to cultural practices, limited access to formal healthcare, or the perceived effectiveness of these remedies. Thus, the indigenous knowledge remains an important component of healthcare in the coastal areas, albeit alongside modern medical practices.

Table 10: Types of Indigenous Treatments Used by Coastal People

	Frequency	Percent
Not applicable	331	86.2
Tree leaves (Medicinal plants)	26	6.7
Arjun tree* skin & leaves, and Neem Patta**	13	3.3
Kobiraji treatment	14	3.6
Total	384	100.0

**Terminalia arjuna* is a tree of the genus Terminalia. It is commonly known as arjuna. It is one of the medicinal plants everywhere like Bangladesh.

**Neem Patta, *Azadirachta indica*, commonly known as neem, nimtree or Indian lilac, is a tree in the mahogany family Meliaceae. It is also one of the medicinal plants everywhere like Bangladesh.

3.10. Disaster management and emergency health services, and school-based health protection programs

Only 24% of coastal residents report the presence of disaster management, emergency health services, and school-based health protection programs in their localities, while the majority (76%) still lack access to such essential services (Figure 3). This highlights a significant gap in the availability of comprehensive health and disaster management programs in coastal areas, where marginalized communities often face challenges in accessing primary healthcare. The absence of these programs poses a critical barrier to improving health outcomes and disaster resilience, suggesting an urgent need for investment in these areas to ensure better access to healthcare and disaster preparedness, particularly for vulnerable populations.

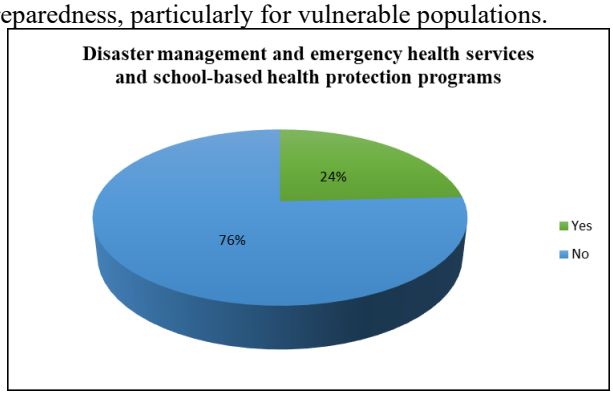

Figure 3: Disaster management and emergency health services and school-based health protection programs

3.11. Access to Medical Services Provided by the Upazila Health Department in Coastal Areas

Only 24% of coastal residents have access to various medical services from the upazila health department, while a significant majority (76%) report not receiving any healthcare services from this crucial institution (Figure 4). This lack of access to upazila health services is concerning, as the upazila health department plays a vital role in providing emergency healthcare, especially to marginalized communities. The absence of these essential services highlights a critical gap in healthcare delivery, underscoring the need for strengthened healthcare infrastructure and improved access to medical care in coastal areas to address the needs of vulnerable populations.

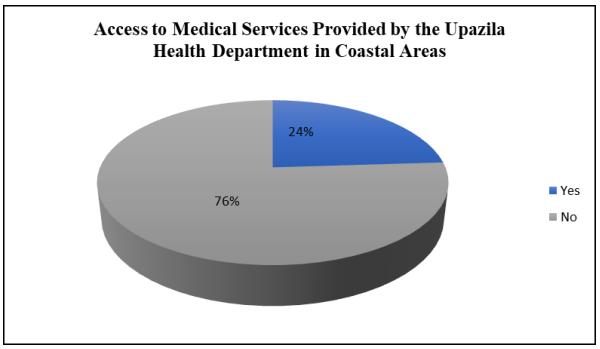

Figure 4: Access to Medical Services Provided by the Upazila Health Department in Coastal Areas

3.12. Awareness of the Bangladesh Health Policy 2011 Among Coastal Residents

Figure 5 shows that only 3% of coastal residents are aware of the Bangladesh Health Policy 2011, a concerning finding given the current era of rapid information exchange and innovation. Even though access to healthcare services is a constitutional right, the lack of awareness about this policy among most of the population highlights a significant gap in public knowledge. Experts suggest that increased awareness of the policy would empower individuals to better advocate for their healthcare needs and access state-provided services. This underscores the need for more effective dissemination of health policy information, particularly in marginalized coastal communities, to ensure that citizens can fully exercise their rights to healthcare.

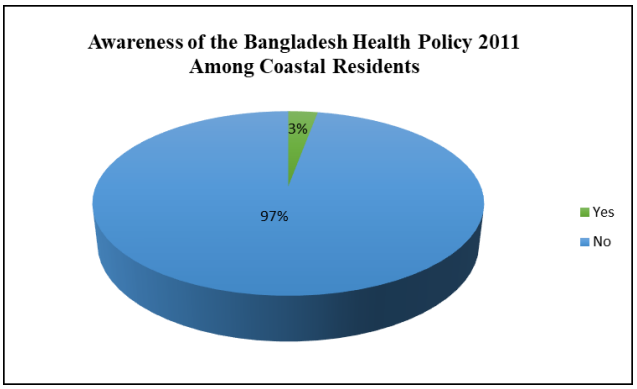

Figure 5: Awareness of the Bangladesh Health Policy 2011 Among Coastal Residents

4. Discussion

The findings of this study underscore the significant gaps in both climate change awareness and healthcare access among coastal communities in Bangladesh. The gender disparity observed, with men being more aware of climate change due to their outdoor occupations, highlights a key issue in climate communication. As women often face restricted mobility and limited access to formal communication channels, their exposure to climate-related information is compromised. This finding aligns with

existing literature that emphasizes the importance of gender-responsive communication strategies to address the barriers women face in accessing vital information on climate risks (O'Brien et al., 2012; Ahmed et al., 2021). In coastal areas where climate change is having a disproportionate impact, these communication barriers exacerbate existing vulnerabilities and hinder adaptation efforts. Furthermore, the study highlights the prevalence of climate-induced disasters, including floods, cyclones, and sea-level rise, which are directly linked to various health issues. These disasters are significantly increasing the incidence of diseases such as respiratory disorders, mosquito-borne diseases, and mental health issues, which are closely tied to environmental stressors. Previous studies have shown that extreme weather events like cyclones and floods have direct health consequences, including increased morbidity from waterborne diseases and vector-borne diseases, as well as mental health issues related to trauma and displacement (McMichael et al., 2020; Rahman & Rahman, 2023). The statistical significance ($p < 0.05$) observed in the relationship between climate events and health outcomes in this study reinforces the findings of these global studies, demonstrating that climate change is not only an environmental issue but also a public health challenge.

Interestingly, despite the availability of modern healthcare systems, 14% of coastal residents still rely on indigenous treatments, primarily due to limited access to formal healthcare services. This trend highlights the continued relevance of local knowledge and traditional remedies in these communities, as well as the barriers that prevent people from accessing formal healthcare. Acknowledging and integrating indigenous knowledge into the healthcare system could help improve service delivery, especially in resource-constrained settings (Schiavetti et al., 2018). It is crucial to bridge the gap between traditional and modern healthcare systems to create a more inclusive and accessible healthcare system for coastal populations. The study also reveals a critical lack of disaster management and emergency health services, with 76% of residents lacking access to such services. This finding is concerning, especially given the increasing frequency and intensity of climate-related disasters. It aligns with other studies that highlight the inadequacy of disaster response mechanisms and healthcare infrastructure in vulnerable areas (Islam et al., 2020). Strengthening disaster preparedness and healthcare infrastructure is essential for improving resilience and ensuring that coastal communities have the capacity to cope with climate-related health risks. The absence of these services underscores the urgency of enhancing disaster risk management and climate adaptation strategies, particularly in marginalized coastal regions.

Finally, the lack of awareness about the Bangladesh Health Policy 2011 among 97% of coastal residents is alarming. Despite healthcare being a constitutional right, this finding points to a significant information gap that prevents communities from fully claiming their rights to health services. The Bangladesh Health Policy 2011, which outlines access to essential health services, has the potential to empower marginalized populations, yet its limited dissemination hampers its effectiveness. This issue has been widely discussed in research that emphasizes the importance of policy awareness in ensuring equitable access to healthcare services (Saif-Ur-Rahman et al., 2019). Effective dissemination of health policies through community-based communication and local networks could help bridge this gap and enable communities to advocate for their healthcare needs. In conclusion, the study highlights the intersection of climate change, healthcare access, and social inequalities in coastal Bangladesh. Addressing these challenges requires a multi-faceted approach, combining gender-responsive communication, integrated healthcare strategies, and improved disaster preparedness. Future policies should prioritize inclusive climate adaptation and public health strategies that empower vulnerable coastal populations, ensuring that they have the information, resources, and services needed to cope with the growing impacts of climate change.

5. Conclusion

The findings of this study underscore the significant gaps in both climate change awareness and healthcare access among coastal communities in Bangladesh. The gender disparity observed, with men being more aware of climate change due to their outdoor occupations, highlights a key issue in climate communication. As women often face restricted mobility and limited access to formal communication channels, their exposure to climate-related information is compromised. This finding aligns with existing literature that emphasizes the importance of gender-responsive communication strategies to address the barriers women face in accessing vital information on climate risks (O'Brien et al., 2012; Ahmed et al., 2021). In coastal areas where climate change is having a disproportionate impact, these communication barriers exacerbate existing vulnerabilities and hinder adaptation efforts. Furthermore, the study highlights the prevalence of climate-induced disasters, including floods, cyclones, and sea-level rise, which are directly linked to various health issues. These disasters are significantly increasing the incidence of diseases such as respiratory disorders, mosquito-borne diseases, and mental health issues, which are closely tied to environmental stressors. Previous studies have shown that extreme weather events like cyclones and floods have direct health consequences, including increased morbidity from waterborne diseases and vector-borne diseases, as well as mental health issues related to trauma and displacement (McMichael et al., 2020; Rahman & Rahman, 2023). The statistical significance ($p < 0.05$) observed in the relationship between climate events and health outcomes in this study reinforces the findings of these global studies, demonstrating that climate change is not only an environmental issue but also a public health challenge.

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