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# Climate Change and Human Health: Unveiling the Perceptions of Kuakata Municipality in Bangladesh

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**Abstract:** Kuakata Municipality, located in the Kalapara Upazila of Patuakhali district, has become increasingly vulnerable to the adverse health impacts of climate change. Owing to its unique topography and coastal setting, the area is highly exposed to natural disasters, which intensify existing environmental and health-related risks. Growing scientific evidence shows that climate change is accelerating, contributing to significant ecological disturbances and posing serious challenges to human well-being. Against this backdrop, the present study investigates community-level perceptions and knowledge gaps concerning climate change and its associated health impacts in Kuakata Municipality. The primary objectives of the study were to assess residents' understanding of how climate change affects human health and to identify possible strategies for minimizing these impacts. A semi-structured questionnaire was used as the main data collection tool, supported by key informant interviews and focus group discussions to ensure the validity of findings and capture diverse community perspectives. The results indicate that climate change has a pronounced influence on human health in Kuakata. Commonly reported climate-sensitive illnesses include diarrhea, skin diseases, headaches, malnutrition, stroke, and hypertension. Climate-induced environmental changes have also contributed to declining agricultural yields, fish populations, and livestock production, which indirectly intensify health vulnerabilities by undermining food security and household livelihoods. A particularly alarming finding relates to the health risks faced by pregnant women, who exhibit heightened susceptibility to complications such as hypertension, premature births, and other climate-related stressors. The study further reveals that while indigenous knowledge and traditional practices are used in some communities to manage climate-related health issues, overall resilience remains limited due to inadequate awareness and insufficient adaptive capacity. Local government initiatives such as training programs and health awareness campaigns have played a positive role in reducing health risks and improving community coping mechanisms. Encouragingly, younger generations demonstrate a higher level of awareness and a stronger ability to adapt compared to earlier generations. Despite these improvements, significant challenges persist. Strengthening healthcare infrastructure, ensuring access to quality

medical services and enhancing community awareness are critical for reducing climate-induced health risks. A comprehensive approach that integrates community participation, indigenous knowledge, and effective government interventions is essential for safeguarding the health and well-being of vulnerable populations in this climate-sensitive region.

**Keywords:** adaptive capacity; climate change; climate-sensitive diseases; coastal vulnerability; healthcare infrastructure; human health; Kuakata Municipality

## 1. Introduction

Climate change represents a rapid progression of extreme weather patterns and environmental transformations occurring at an unprecedented scale. The interaction between human systems and climatic disturbances, rather than the hazards alone, plays a decisive role in shaping the severity of impacts [1,2]. Bangladesh, identified as the seventh most climate-vulnerable coastal country globally, faces heightened risks due to its geographical location, low-lying topography, and exposure to multiple climatic hazards [3]. Over recent decades, the country has witnessed an increase in the frequency and intensity of extreme climatic events, disproportionately affecting coastal and riverine communities with low adaptive capacity [4–6]. Almost every year, tropical cyclones severely devastate agricultural fields in countries in the Global South [7]. Climate hazards refer to the potential harmful effects on human life resulting from variables within the climate or weather system [8].

Climate and pollution factors severely affect the health sector [4,9–12]. Health and climate change are linked, and this is becoming a significant concern worldwide [13]. Climate change impacts are noticeable in major staple crops, vegetation, human health, livestock, and the effects of natural disasters [14]. Climate change is expected to exacerbate the prevalence of diarrhoeal diseases and modify the geographical distribution of certain infectious disease vectors, since elevated average temperatures facilitate the growth of regions suitable for certain "tropical" diseases [15]. Existing evidence links climate variability to a range of diseases, including cardiovascular illnesses, respiratory infections, gastrointestinal infections, altered transmission of vector-borne diseases, and malnutrition due to crop failure [16,17]. Rising temperatures, changing precipitation patterns, saline intrusion, floods, cyclones, and prolonged heat waves all exacerbate health vulnerabilities [18–21]. In coastal Bangladesh, salinity-affected drinking water has been associated with diarrhea, cholera, hypertension, preeclampsia, preterm birth, skin infections, and acute respiratory disorders [22–24]. Malnutrition, food, water, and vector-borne illnesses, as well as an increase in morbidity from the confluence of high temperatures and air pollution, are examples of indirect consequences [25]. Water contamination following storms and floods heightens the incidence of waterborne diseases, while repeated climate shocks can contribute to long-term mental health impacts [26,27]. Climate change, therefore, disproportionately affects low-income populations, women, children, and communities lacking strong adaptive capacity. Unquestionably significant are the indirect effects of climate change, such as stress-related mental health issues, homelessness, unstable economic conditions, and forced migration. The most vulnerable groups to the negative consequences of climate change include children, the elderly, and impoverished communities [28].

The Fourth Assessment Report of the IPCC 2001 made it abundantly evident that climate change affects the worldwide burden of diseases and premature mortality [29]. The Health Sector Assessment (HSA) determined that climate variability and change are expected to elevate morbidity and mortality risks for several climate-sensitive health outcomes, with the overall impact remaining unknown [30].

Despite a growing body of research linking climate change and public health in Bangladesh, significant gaps remain. Most existing studies focus on broad national-level assessments or specific health outcomes but provide limited localized evidence on community perceptions, indigenous coping strategies, and public health preparedness, particularly in small coastal municipalities such as Kuakata. Moreover, there is insufficient understanding of how climatic stressors interact with local socioeconomic conditions to shape health risks at the household and community levels. As a result, policy interventions often remain generalized and fail to address context-specific vulnerabilities.

Kuakata Municipality, located along the exposed coastal belt of Patuakhali district, faces the dual challenge of accelerating climate impacts and growing public health concerns. Yet empirical research examining how residents perceive climate risks, how these risks affect their health, and how effectively the existing health system supports adaptive capacity is limited. Addressing this gap is essential for designing targeted and sustainable health adaptation strategies. The present study investigates the complex relationship between climate change and human health in Kuakata Municipality. Specifically, it (i) assesses community perceptions of climate change and its health impacts; and (ii) evaluates existing adaptive strategies and public health infrastructure to propose effective

interventions. By focusing on a highly vulnerable coastal municipality, this research contributes localized insights that can guide policy formulation, community-based action, and future academic inquiry. Ultimately, understanding the vulnerabilities and resilience mechanisms of Kuakata residents is crucial for safeguarding public health in an era of accelerating climate change.

## 2. Methodology

### *2.1. Description of the Study Area*

In this research, a coastal district of Bangladesh named Patuakhali was selected, as it is in the southern part of the country. Subsequently, the Kuakata municipality was selected from this district. This municipality is a distinct geographical area distinguished by its coastal beauty and the confluence of the Bay of Bengal and the Tentulia River. It is situated in Kalapara Upazila. The geographical location of the area in question is specified by the following coordinates: 21.8182° N, 90.1398° E (Figure 1). The total population of Kuakata Municipality is 9177, comprising 5043 males and 4134 females. Moreover, the total number of households in the region was documented to be 2065, and the literacy rate was recorded to be 57.6 percent, according to the reports of the 2011 BBS. The selection of this study area was driven by the prevalence of challenges faced by the local populace, including losses in fish and livestock production and yield due to salinity and drought. These challenges have had severe health implications for the community, exacerbated by the effects of climate change.

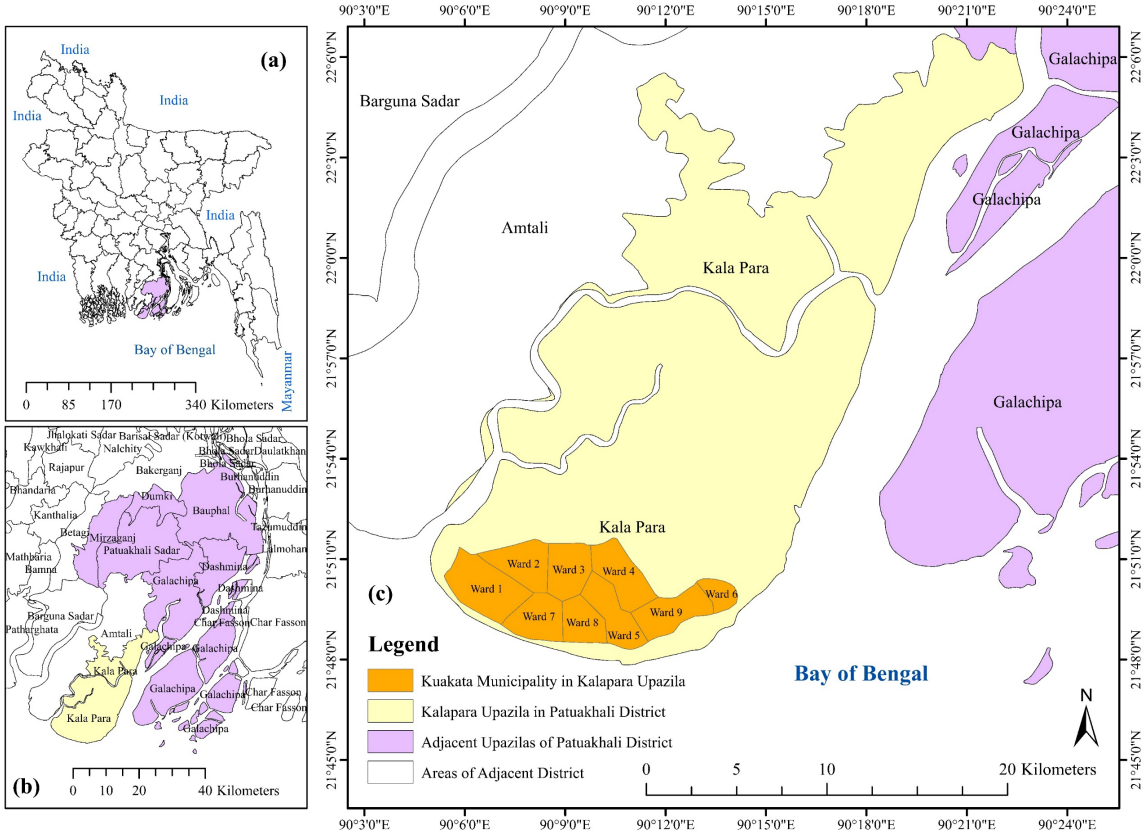


**Figure 1.** Maps of the study area: (**a**) Patuakhali District in Bangladesh; (**b**) Kalapara Upazila in Patuakhali District; (**c**) Kuakata Municipality in Kalapara Upazila of Patuakhali District.

### *2.2. Sampling Methods*

A total of 130 households were surveyed from the 2065 households of Kuakata Municipality, a purposively selected coastal area in Bangladesh, highly vulnerable to cyclones, storm surges, and salinity intrusion, impacting residents' health. Households were drawn from diverse geographic locations: sea-adjacent settlements; areas near coastal embankments and dams; and locations close to and distant from cyclone shelters that capture the varying level of climate hazard exposure to ensure representativeness. Various demographic and socioeconomic characteristics, such as gender, age, income, occupation, farm size, and education, were represented by respondents. A convenience sampling technique was used to target households directly affected by the climate hazards but also included diversity across geographic zones and socioeconomic backgrounds.

The sample size is calculated through the following equation: Sample size calculation equation is elucidated by:

$$\eta = \sqrt{(1.96 \times \sigma)/P} \quad (1)$$

where, σ = standard deviation, η = sample size, P = proportion to be estimated = 0.5, t = 1.96 at 95% confidence level.

The inclusion criteria were permanent residence in the municipality, age ≥ 18 years, and residence in the locality for at least five years. Of the 160 households contacted, 130 participated, giving a response rate of 81.25%. Data collection was done using a structured questionnaire with both closed- and open-ended questions, allowing respondents to provide experience and local climate-risk-reduction strategies, which were then systematically coded into quantitative indicators. While convenience sampling may introduce some selection bias, and households outside the defined coastal exposure zones were excluded, the geographic and socioeconomic diversity of the sample, combined with structured data collection and coding, ensures the credibility, representativeness, and validity of the findings.

### *2.3. Data Collection*

In this research, an interdisciplinary approach encompassing experimental, qualitative, and quantitative methods was employed. The data presented herein was obtained from both primary and secondary sources. To collect primary data, a standardized questionnaire survey was conducted, in addition to focus-group discussions and key informant interviews. For primary data collection, participants were selected from the local community. Before the administration of the questionnaire survey, a field observation will be conducted to ascertain the overall condition and practical circumstances of the study area.

In this study, the primary data were collected through a mixed-method approach combining a standardized household questionnaire survey, focus group discussions, and key informant interviews. To supplement and triangulate the survey findings, three FGDs were organized with more than 15 participants representing diverse age groups, occupations, and social backgrounds, who were particularly vulnerable to climate-related hazards. These discussions explored community perceptions of climate change, health risks, coping strategies, institutional support mechanisms, and challenges faced in overcoming the climate-induced health problems. The information from FGDs was cross validated through four KIIs with people who possess specialized knowledge and experience, such as an MBBS doctor, a healthcare worker, a religious leader, and a Union Parishad member. The KIIs yielded expert insights on disease patterns, community health vulnerabilities, and contextual factors influencing risk. Together, the household survey, FGDs, and KIIs assured methodological rigor by capturing the quantitative and qualitative dimensions of the climate-related health impacts; hence, they enhanced the reliability and validity of the study.

Secondary data was collected from the Kalapara Upazila Office in Patuakhali. To augment the extant corpus of knowledge on the subject, additional information about climate change and its impacts on human health was collected from the journals, books, newspapers, and websites of the Bangladesh Climate Change Trust and the Ministry of Environment, Forest, and Climate Change.

### *2.4. Data Analysis*

The data from the household survey were collected using the Kobo Toolbox digital platform and then exported to Microsoft Excel for cleaning, coding, and consistency checking. The dataset was then analyzed using IBM SPSS Statistics (Version 23), Microsoft Excel 2019, and ArcGIS 10.8. Both descriptive and inferential statistical methods were applied. Descriptive statistics like frequencies, percentages, means, and standard deviations were employed to describe socio-demographic characteristics, impacts on livelihoods, yield loss, fish and livestock losses, and climate-related health problems. Likert scale items of perceived climate vulnerability across five sensitive groups-women, children, older adults, persons with disabilities, and pregnant women-were analyzed for reliability analysis using Cronbach's Alpha and interpreted further through descriptive measures. Visual representations in pie charts, bar charts, and frequency tables were created using SPSS and Excel to present the key trends of the data. The associations between climate variables and perceived health risks were tested by using Pearson's correlation analysis. Spatial mapping of the study area and hazard exposure patterns was conducted using ArcGIS. This combined analytical approach ensured a sound integration of statistical, spatial, and perceptual data, enhancing the reliability and interpretive depth of the study findings.

### *2.5. Research Ethics and Consent*

The participants in this study were selected randomly, and they all answered all the questions voluntarily after giving their consent to conduct the survey. In the case of local disaster vulnerability causes and mitigation

methods, the questions were pre-examined before collecting final data for realization. The research objectives of all participants were explained before the start of the study, and the study was conducted at the time and place according to their convenience. Since the participants participated spontaneously, no financial assistance was provided to them. No money was paid to any local organization or individual while collecting the information, and we also did not face any problems. Moreover, respondents' consent has also been taken to share photographs in the paper.

## 3. Results and Discussion

### *3.1. Demographic and Socio-Economic Characteristics of the Respondents*

The analysis primarily focuses on finding out the people's perceptions of climate change impacts on human health in the Kuakata municipalities of Patuakhali district. Determining the demographic and socioeconomic status of respondents is a very important step in understanding the impact of climate change on human health, as that impact depends on the demographic and socioeconomic conditions of the respondents. A demographic profile includes the gender, age, education status, occupation, and income condition of the respondents. In the following study, the demographic aspects are given below:

- The gender distribution of the respondents. While the study had households from diverse socio-economic backgrounds, about 87% of the respondents were males (shows Table 1). This is due to the socio-cultural environment of the place under study. In Kuakata, most women work either in the local hotels or other tourism industries, that make it difficult for them to be available during household survey times. Besides, a significant portion of the women also observe purdah, thereby decreasing their willingness to engage in interviews with an unknown surveyor. In these circumstances, female members of such households would instead prefer to share their experiences and health-related concerns with the male members of their families. Consequently, these data may not fully represent a woman's view, especially in the case of gender-specific and maternal health issues. Therefore, this study avoids strong gendered health claims and keeps this as a limitation of interpretation.
- Table 2 shows the percentage of the age distribution of the respondents who attended our survey in the Kuakata municipalities of Patuakhali District. In this study, six different age categories of respondents participated in our survey, with 35% aged 31–40 years and 24% falling within the 41–50 age group. Additionally, 14% of the respondents were in both age groups of 20–30 and 51–60 years, while only 7% and 6% of the respondents were in the 61–70 and 71–80-year age groups, respectively.
- Table 3 is a graphical representation of the educational levels of households and the distribution of those levels among the various categories. Based on the findings, it's evident that 42% of households have a primary level of education due to financial constraints, an inability to afford educational costs, and a lack of social facilities hindering access to continued education. Additionally, 27% of respondents have no educational qualifications and are unable to read or sign, while 21% have completed high school. Furthermore, 8% of respondents have attained a college degree, while only 2% have completed a graduate degree. These findings indicate a concerning level of education among respondents. Consequently, a significant portion of the respondent's lack awareness of climate change and its potential impacts on their livelihoods due to their limited education.
- Table 4 shows the livelihood strategies of households in Kuakata municipalities in Patuakhali District. The majority, approximately 28% of the respondents, were involved in fishing for their livelihood, while around 22% of the respondents worked as wage labor for their livelihood. Additionally, for the respondents who did crop production and other activities for their livelihood, both proportions were about 15%. Furthermore, approximately 11% of the participants were involved in manufacturing professions, and only around 9% of participants were involved in livestock production in their occupations. Many others have also argued about the increase in salt content in the sea, leading them to change their professions from fishermen to day laborers, among other occupations (Indigenous Knowledge-Based).
- Table 5 shows the percentage of respondents' income scenarios in the Kuakata municipality area. In this study, we collected 130 households' monthly income levels in five different categories. Among these respondents, 62% of the household's monthly income was between approximately 10,000 and 20,000 Tk., and 25% of the respondents' monthly income was between around 20,000 and 30,000 Tk. Additionally, respondents whose income level was less than 10,000 Tk. and between 30,000 and 40,000 Tk. had a proportion of approximately 6%. Interestingly, only around 1% of the respondents' monthly income level was between 40,000 and 50,000 Tk, which means they were the richest people in this area. Most of the fishermen respondents said that they didn't have equal income every month at sea because they did not catch fish due to natural disasters, as well as government laws. Additionally, most of the wage laborers also said

that they hadn't worked all year, and during the disaster, they could not go out for work. Moreover, the farmer community also claimed that they could not grow much paddy in their field, and as a result, their income level declined from before.

**Table 1.** Respondents by gender.

| Gender | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Male | 113 | 86.9% | 86.9 | 86.9 |
| Female | 17 | 13.1% | 13.1 | 100.0 |
| Total | 130 | 100.0 | 100.0 | |

Source: Field Survey, 2023.

**Table 2.** Respondents by age class.

| Age Class | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| 20–30 | 18 | 13.8% | 13.8 | 13.8 |
| 31–40 | 45 | 34.6% | 34.6 | 48.5 |
| 41–50 | 31 | 23.8% | 23.8 | 72.3 |
| 51–60 | 19 | 14.6% | 14.6 | 86.9 |
| 61–70 | 9 | 6.9% | 6.9 | 93.8 |
| 71–80 | 8 | 6.2% | 6.2 | 100.0 |
| Total | 130 | 100.0 | 100.0 | |

Source: Field Survey, 2023.

**Table 3.** Respondents by education level.

| Level of Education | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| No Education | 35 | 26.9 | 26.9 | 26.9 |
| Primary Level | 55 | 42.3 | 42.3 | 69.2 |
| High School | 28 | 21.5 | 21.5 | 90.8 |
| Collage | 10 | 7.7 | 7.7 | 98.5 |
| Bachelors | 2 | 1.5 | 1.5 | 100.0 |
| Total | 130 | 100.0 | 100.0 | |

Source: Field Survey, 2023.

**Table 4.** Respondents by their livelihood strategy.

| Livelihood Strategy | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Fishing | 37 | 28.5 | 28.5 | 28.5 |
| Wage labor | 28 | 21.5 | 21.5 | 50.0 |
| Crop Production | 19 | 14.6 | 14.6 | 64.6 |
| Manufacturing | 15 | 11.5 | 11.5 | 76.2 |
| Livestock production | 12 | 9.2 | 9.2 | 85.4 |
| Others | 19 | 14.6 | 14.6 | 100.0 |
| Total | 130 | 100.0 | 100.0 | |

Source: Field Survey, 2023.

**Table 5.** Respondents by their income range in Bangladeshi Taka (Tk.).

| Income Range | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Less than 10,000 Tk. | 8 | 6.2 | 6.2 | 6.2 |
| 10,000 to 20,000 Tk. | 81 | 62.3 | 62.3 | 68.5 |
| 20,000 to 30,000 Tk. | 32 | 24.6 | 24.6 | 93.1 |
| 30,000 to 40,000 Tk. | 8 | 6.2 | 6.2 | 99.2 |
| 40,000 to 50,000 Tk. | 1 | 0.8 | 0.8 | 100.0 |
| Total | 130 | 100.0 | 100.0 | |

Source: Field Survey, 2023.

### *3.2. Climate Change Scenario and Associated Problems*

#### 3.2.1. Temperature Increase

In the field survey, we sought to understand people's perceptions regarding the rise in temperature in the study area. Based on their responses, we found that 96% of households stated that the temperature has drastically increased at present. They claim that they were unable to do something outside of their home due to the high temperature, and when they go out in extreme heat, their skin becomes burnt and itchy. A survey of the dermatologic impacts of severe weather suggests that excessive heat and sweating may trigger or cause an eruption of pruritic skin dermatology, such as heat-exacerbated dermatoses [31]. Sometimes, salt residue can be observed when their sweat dries on their bodies. Consequently, their children suffer from various diseases, including diarrhea, itching, and headaches. They attribute all their problems to the increasing temperatures. A systematic review and meta-analysis indicate that higher levels of ambient temperature tend to be related to higher rates of all-cause and bacterial diarrheal disease in general, but the effects in each case are different in strength [32].

On the other hand, only 4% of respondents indicated that the temperature has not increased or that they are unable to discern any change, attributing this to constantly being indoors with fans and avoiding exposure to sunlight. Therefore, they do not perceive it as a problem. Interestingly, these 4% represent the affluent members of society.

#### 3.2.2. Climate-Induced Disasters

Figure 2 illustrates the distribution of climate-induced disasters reported in the Kuakata Municipality of Patuakhali District. According to respondents, cyclones (42%) and salinity intrusion (35%) are the most frequently occurring disasters linked to climate change. Most participants noted that these hazards have become increasingly common in recent years. Field-based research in Galachipa Upazila, Patuakhali District, suggests that the area is extremely susceptible to tropical cyclones and addresses cyclones as a major coastal risk with major repercussions on the livelihoods locally [33]. Furthermore, Water samples at the Kuakata (Kalapara, Patuakhali) villages indicate that most of the groundwater is not consumable due to its high electrical conductivity and chloride levels, and show that the southern section of the Kuakata beach is intruded by salty water, thus supporting salinity as a significant climate-driven problem [34]. In contrast, drought (12%) and waterlogging (9%) were identified as less frequent but still significant challenges for the community.

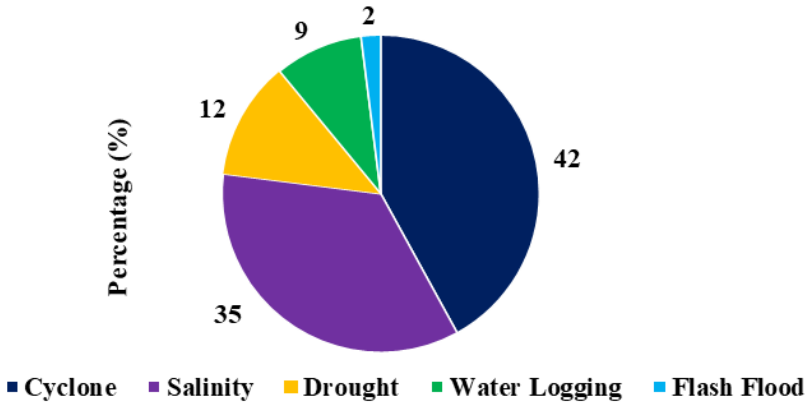


**Figure 2.** Climate-induced disasters.

Only 2% of respondents reported the occasional occurrence of flash floods, though many within this group believed these events were high tides rather than true flash floods. Overall, the findings indicate that Kuakata Municipality is highly vulnerable to climate change impacts, particularly waterlogging, flooding from cyclones, and increased salinity. Respondents noted that cyclones have become more frequent and destructive in recent years, causing significant loss of livelihoods and property. Many fishermen also reported shifting occupations due to declining fish availability associated with rising salinity levels.

#### 3.2.3. Yield Loss Due to Salinity

Figure 3 shows the yield loss due to salinity in the Kuakata municipalities of Patuakhali District, dividing the yield loss into five different categories: high, very high, moderate, low, and very low. Most respondents reported

that yield loss (48%) is caused by very high salinity. A study shows that the reduction of the high-yield rice production will occur by about 15.6 per cent in the sub-districts in which the salinity has already reached critical levels, thus showing that it has significantly reduced the production of high-yield rice due to the salinization [35]. Additionally, 31% of respondents claimed that high salinity followed their yield loss, while 12% responded moderately. Survey of upazilas within the coastal areas of Patuakhali and Satkhira showed that primary crop yields (e.g., rice) were severely affected by salinity-based climatic stressors, as indicated by local farmers. Furthermore, 8% of respondents indicated their yield loss was low, and only 1% stated their yield loss was very low.

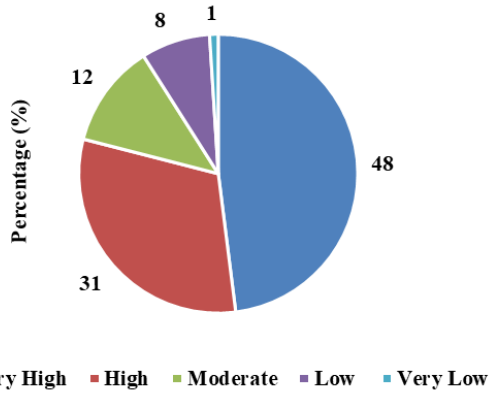


**Figure 3.** Yield loss due to salinity.

The data indicates the severity of the salinity problem in Kuakata municipalities and its impact on agricultural production. Respondents from the Kuakata municipalities were unable to grow yields in their fields and homes. Many female respondents also reported that they could grow vegetables in their home garden before, but in recent years, they could not grow any vegetables in their garden. Consequently, they faced several health problems due to not getting proper nutrition from vegetables. The rice production in coastal Bangladesh is being negatively impacted by salinity intrusion in soil brought on by climate-related hazards, particularly cyclones and sea level rise (SLR) [36,37].

### 3.2.4. Losses of Fish Production Due to Salinity

Figure 4 indicates the losses in fish production due to salinity and climate change in the study area. Most respondents reported that the highest fish production loss (37%) occurs at very high salinity/climate change impacts. In the study area, a fisherman said, "There are no more fish than before because of the increase in salinity in the sea. Previously, he used to make his living by fishing, but now it is no longer possible. The small number of fish he catches is only enough to feed his family, not for sale. A study evaluated the negative impact of increased aquatic salinity caused by climate change on fish environments and the surrounding communities in southwestern coastal Bangladesh. Their model suggests that climate-driven salinization triggers the decrease in fish species diversity and the associated livelihoods, especially among the poor households, thus creating an obvious nexus between the rise in salinity due to climate change and loss in fisheries production [38].

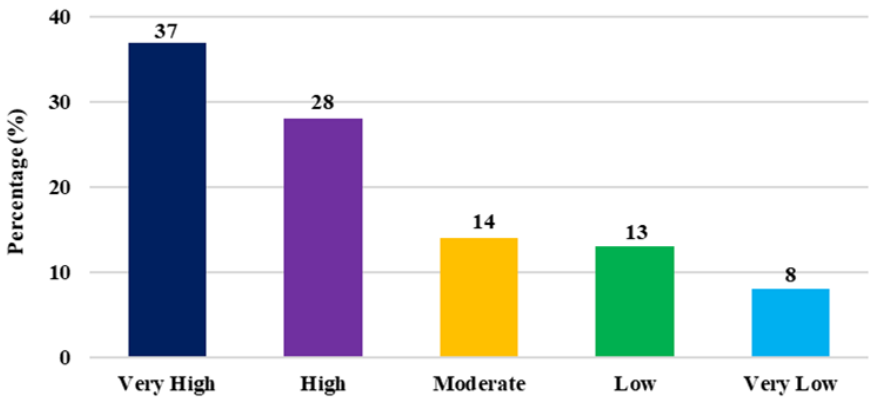


**Figure 4.** Losses of fish production due to salinity.

28% of fish production losses are due to high salinity and climate change impacts. Additionally, respondents also claim that 14%, 13%, and 8% of fish production losses, respectively, cause moderate, low, and very low salinity and climate change impacts. These data indicate the negative effects of salinity and climate change on fish production in the study area. A similar study claimed that due to salinity, fish production declined and led to a higher risk of food shortage, hunger, and various illnesses [39].

### 3.2.5. Respondents' Health Impact Due to Losses of Livestock Production

Figure 5 presents the health impacts associated with losses in livestock production in Kuakata Municipality. Respondents identified health breakdown (30%) as the most common impact, followed by reduced nutrition (22%) and decreased protein sources (19%). High temperatures, changing rainfall patterns, drought, floods, riverbank erosion, and salinity have a severe negative effect on the production of crops and livestock, in turn, lowering the quality of feeds and fodder, as well as the productivity of livestock [40]. Additionally, 15% reported malnutrition and 8% noted vitamin deficiencies. Only 6% claimed that there were no health impacts, mainly because they do not raise livestock and rely on the market for animal products. Most participants explained that declining livestock production is largely caused by increased salinity, which prevents grass from growing and sustaining animals, and has contributed to various health problems, including poor nutrition, vitamin deficiencies, and reduced protein intake.

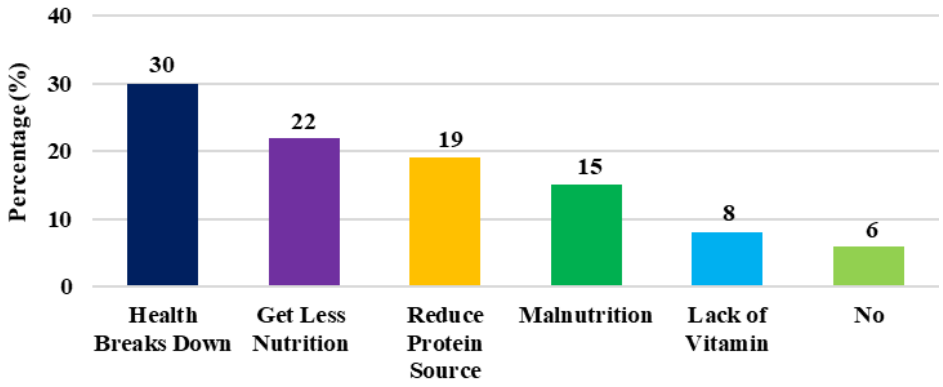


**Figure 5.** Respondents' health impact due to losses of livestock production.

In the study area, a wage laborer said, "Earlier, she used to keep a lot of donkeys, chickens, cows, and goats, but now she doesn't keep them anymore. Because they die after consuming salt water. Once her 15 ducks went into the salt water, they all died". These data indicate that the losses in livestock production have serious effects on the people of the Kuakata municipalities in Patuakhali District. A study also claimed that due to loss of livestock, proper intake of food can be reduced, causing health issues among the coastal people of Bangladesh [41].

### 3.2.6. Respondents' Health Problems Due to Salinity

Figure 6 illustrates the major health problems caused by salinity in the study area. A large proportion of respondents (41%) reported high blood pressure as the most common issue, contributing to an alarming rise in stroke and heart disease. A study carried out in coastal Bangladesh showed that respondents exposed to a greater amount of salinity in their drinking water had a much higher systolic and diastolic blood pressure compared to those exposed to lower levels of salinity, which means that there was a high risk of developing hypertension and cardiovascular disease [42]. Additionally, 25% experienced skin-related problems such as allergies, infections, and rashes, while 21% reported hair loss. About 13% indicated exposure to carcinogenic risks. Many respondents noted that seawater salinity has increased significantly in recent years, and strong coastal winds now carry salt further inland. As a result, the prevalence of high blood pressure, skin diseases, hair loss, and cancer-related risks continues to grow in the community.

A fisherman said, "Now, due to the rise in the amount of salt in salt levels in the sea, fish are not as abundant as they used to be. However, now it is not possible to stay at sea for an extended period due to the salty air. The effects of carcinogenic diseases and widespread skin ailments make staying for more than 2 to 3 days very difficult. Staying longer than this can result in severe illness, necessitating a long period of bed rest. Consequently, people in their area suffer from various nutritional deficiencies due to insufficient intake of nutrients and meat. Financially poor people cannot afford treatment; sometimes they must sacrifice their lives for it". Therefore, based on people's perceptions, we identified that the people of the Kuakata municipalities faced the serious health consequences of

salinity. A similar study claimed that due to salinity, coastal people face skin diseases and hair loss. They also mentioned that women become unattractive, so they reduce their social interactions [43,44]. According to the perceptions of individuals living in Bangladesh's southern coastal zones, the local population most frequently experiences skin conditions, diarrhea, dysentery, indigestion, gestational hypertension, and high blood pressure as a result of the rising salt [45–47]. Higher drinking water salinity is linked to an increased risk of hypertension, especially in Bangladesh's youth coastal communities [48,49].

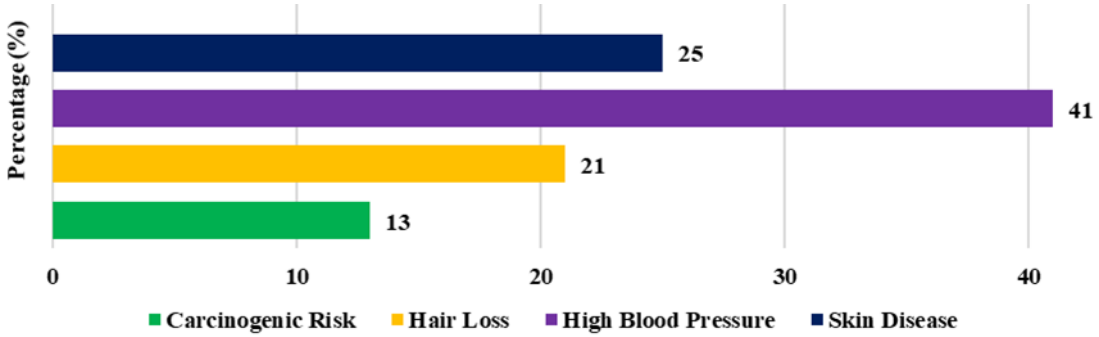


**Figure 6.** Respondents' health problems due to salinity.

The gastrointestinal tract and the cardiovascular system are especially susceptible to the negative consequences of global warming. Climate change also affects some infectious diseases and their animal vectors, increasing the chance of contracting West Nile virus, cholera, malaria, dengue, and typhus. However, in multitudes, warming might lower the incidence of cold-related illnesses such as pneumonia, bronchitis, and arthritis, but these advantages are unlikely to offset the hazards [17].

The widespread prevalence of salinity-related health issues in Kuakata Municipality underscores the need for targeted interventions. In collaboration with the Patuakhali District Health Office, Kuakata Municipality could strengthen community-based health services through periodic screening for hypertension and skin diseases, particularly in the most affected wards. Additionally, mobile health clinics, saline-free drinking water points, and community awareness programs could help reduce exposure and improve early detection among vulnerable groups.

### 3.2.7. Problems during Pregnancy Due to Salinity

Figure 7 illustrates various pregnancy-related health problems linked to salinity in the Kuakata municipality area, categorized into urine problems, hypertension, high blood pressure, uterine cancer, and other issues. Most respondents reported hypertension as the most common complication (49%), often leading to dangerously high blood pressure, heart disease, and stroke. Urinary problems were identified as the second most common issue (28%), causing frequent and painful urination, while 21% noted cases of uterine cancer; only 2% mentioned other complications. The contamination of drinking water with high salt levels has been favorably linked to the higher risk of (pre-) eclampsia and gestational hypertension in pregnant women, with the risks increasing with the level of sodium concentration in the drinking water [50]. According to respondents, women experience multiple health risks during pregnancy due to salinity, resulting in higher rates of premature deaths among both mothers and newborns. They also attributed these fatalities to inadequate healthcare services and limited access to treatment.

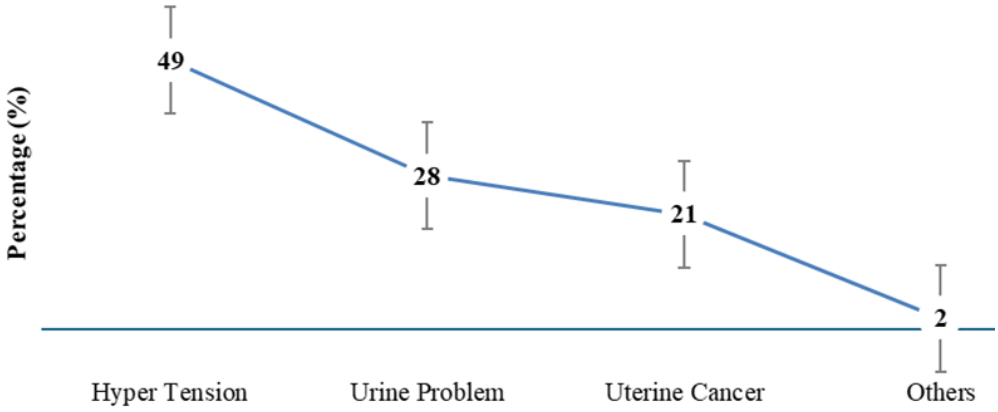


**Figure 7.** Problems during pregnancy due to salinity.

Consequently, they are unable to adequately fulfill their familial responsibilities. It is evident that marital discord is an inherent element of familial dynamics, with disputes between spouses being a recurring theme. Notably, instances of divorce have been observed within several families. The data indicate that women residing in coastal areas encounter not only significant health complications but also social challenges during pregnancy, attributable to salinity. Additionally, another study also mentioned in their study that salinity affects the reproductive health of women [51,52]. Sometimes, women also face early birth and uterine diseases due to salinity.

### 3.2.8. Food & Clean Water Accessibility in Cyclone Shelters

Most of the respondents, 72%, reported that they did not get any food or clean water in cyclone shelters during disasters. On the other hand, only 28% of respondents answered positively that they get some dry food and one liter water bottle, but these were so low that they could not survive with them. Unhealthy sanitation, scarcity of safe drinking water, inadequate medical facilities, limited or almost no facilities for women, especially for pregnant women, are the limitations of coastal areas' cyclone shelters [53].

During their stay in the shelter, many suffer from stomach aches and gastric problems, and their health deteriorates due to a lack of healthy food and clean water. Children suffer from diarrhea, fever, vomiting, etc. Also, children, the elderly, and pregnant women do not get any additional facilities. This affects the health of everyone. From people's perceptions, we understood that the cyclone shelter's conditions were very poor and lacked several resources. As a result, this area needs more cyclone shelters, and the old ones need more improvement so that the victims get proper shelter in the cyclone shelters.

To address the documented 72% lack of access to food and clean water in cyclone shelters, a shelter-management policy could be adopted by the authority of Kuakata Municipality, which could offer pre-positioned water filtration units, saline-free storage tanks, and emergency dry food reserves. Special attention should be given to vulnerable groups, including children, pregnant women, and elderly people, to reduce disaster-related health risks.

### 3.2.9. Yield Loss Assessment Due to Drought

Figure 8 shows the people's perceptions about how much yield losses were due to drought in the Kuakata municipality area, where we compared the proportion of drought severity at five levels, such as very high, high, moderate, low, and very low. Most respondents (55%) said that the highest yield loss happened at high drought severity, and they also claimed that most of the yield loss occurred due to drought after salinity. They could not grow any crops well, and as a result, everything was burned at high temperatures. The most drastic cases of drought-related yield losses are between 45 and 60 % with rice and 50 and 70 % with highland crops. Loss of rice yield in mild cases of drought is between 10 to 30% [54,55]. Additionally, 27% of respondents reported moderate drought severity, and 9% of respondents reported a low severity of yield loss due to the drought. Moreover, 6% and 3% of respondents also claim very low and very high drought severity yield losses, respectively.

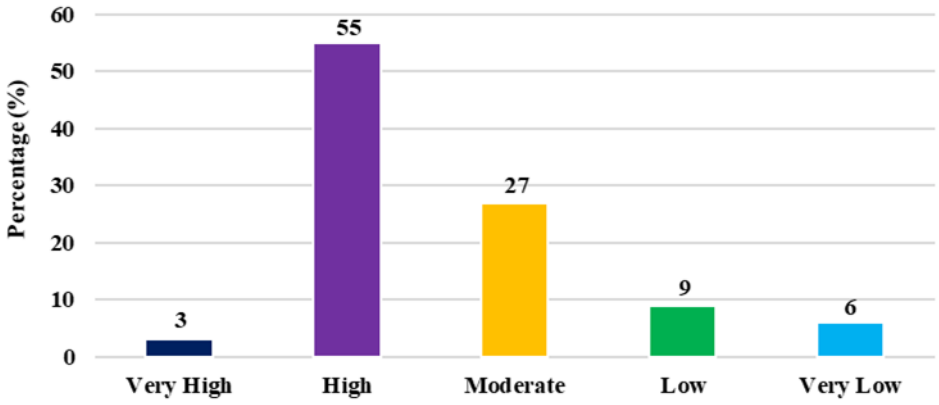


**Figure 8.** Yield loss assessment due to drought.

Barek Miah, a poor farmer, expressed concern, stating, "Currently, the air temperature has increased sharply. As a result, the amount of salt in the seawater has also increased manifold. In such a situation, if the crop is sown on the land, it gets burned after a few days. Crops that do not grow as well. Additionally, crop production has decreased many times. From people's perceptions, we indicate the negative effects of drought on yield production in the Kuakata municipality area.

To address the yield loss issue, some policy recommendations should be considered, such as drought-resistant crop varieties, community-based irrigation support, and farmer training on water-saving techniques and climate-smart agriculture.

#### 3.2.10. Age Groups That Are Affected by Health Problems

Table 6 shows the descriptive statistics related to different age groups, such as women, children, the old, disabled, and pregnant women, who primarily face health problems. The table indicates that no data was missing for any of the demographic groups, with a total valid sample size of 130 for each group. The mean scores range from 3.94 to 4.29, with the values for the individual age groups being 4.29 > 4.22 > 4.19 > 4.05 > 3.94, indicating that disability, the old, pregnant women, and children respectively. Additionally, the standard deviation scores range from 0.892 to 1.268, with the values for the individual age groups being 1.268 > 1.266 > 1.182 > 1.036 > 0.892, which indicates that children, individuals with disabilities, pregnant women, the elderly, and women, respectively, have the highest standard deviations.

**Table 6.** Various age groups that are affected by health problems.

| Descriptive Statistics | Women | Children | Old | Disability | Pregnant Women |
|---|---|---|---|---|---|
| Valid | 130 | 130 | 130 | 130 | 130 |
| Missing | 0 | 0 | 0 | 0 | 0 |
| Mean | 4.05 | 3.94 | 4.22 | 4.29 | 4.19 |
| Median | 4.00 | 4.00 | 5.00 | 5.00 | 5.00 |
| Mode | 4 | 5 | 5 | 5 | 5 |
| Std. Deviation | 0.892 | 1.268 | 1.036 | 1.266 | 1.182 |
| Variance | 0.796 | 1.609 | 1.074 | 1.604 | 1.397 |
| Range | 3 | 4 | 3 | 4 | 4 |
| Minimum | 2 | 1 | 2 | 1 | 1 |
| Maximum | 5 | 5 | 5 | 5 | 5 |
| Sum | 527 | 512 | 549 | 558 | 545 |

The highest mean values are observed among the age groups of individuals with disabilities (4.29), the elderly (4.22), and pregnant women (4.19), with median and mode values of 5 for all except children. Moreover, the age group with the highest standard deviation values is that of children (1.268), individuals with disabilities (1.266), and pregnant women (1.182). Consequently, these data demonstrate that these age groups are the most vulnerable to health problems during disasters. Based on these statistics, it is suggested that children, individuals with disabilities, and pregnant women are the most susceptible age groups, as they are more likely than women and older adults to experience health issues at a younger age and to exhibit a greater spectrum of vulnerability.

### *3.3. Mitigation Strategy of the Household*

#### 3.3.1. Resiliency Status of the Community Houses against Health Impact

Figure 9 shows the resiliency status of community houses against health impacts in Kuakata municipalities during natural disasters induced by climate change. This assessment was conducted by comparing the percentage of houses at various levels of resiliency, such as high, very high, moderate, low, and very low. Most respondents (68%) pointed out that their houses have low resilience, and as a result, they were vulnerable to health risks due to a lack of proper housing availability during cyclones, coastal flooding, storm surges, and so on.

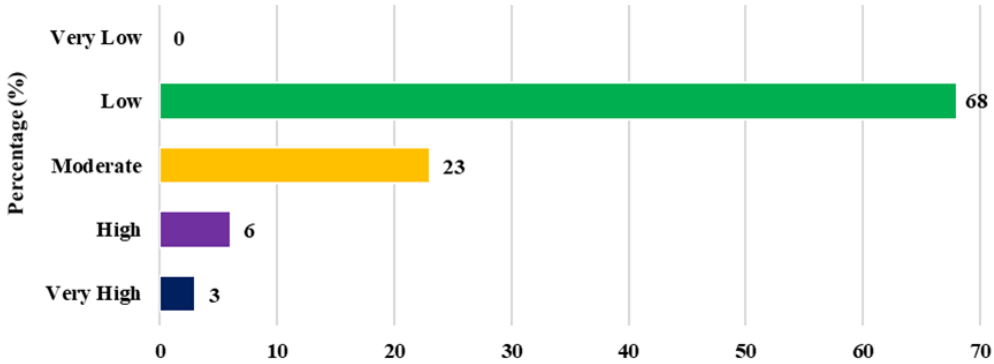


**Figure 9.** Resiliency status of the community houses against health impact.

Additionally, 23% of respondents claim they have moderate resiliency housing capacity, and 6% of the respondents have high resiliency housing capacity during disastrous periods. Furthermore, only 3% of respondents had very high-resiliency housing against disastrous situations, and there were no respondents who had very low-resiliency housing during the time of disasters.

Besides, there are not enough cyclone shelters in our area. Consequently, during cyclones, they go to local hotels and take shelter. And by doing so, they get into various problems, especially with food and drink. Due to a lack of adequate food and drink, they suffer from various diseases, greatly impacting their health.

### 3.3.2. Knowledge Level about Climate-Induced Health Impact

Figure 10 shows the percentage of respondents' knowledge levels about the health impact of climate change in the Kuakata municipality area, where we consider them in three groups based on their good, moderate, and poor knowledge levels. Most respondents (50%) have limited knowledge of the health effects of climate change, which means they are unaware of the health impact due to climate change. Additionally, 38% of the respondents have moderate knowledge, which indicates that they have only some basic knowledge about this issue but not enough clarity on this problem. On the other hand, only 12% of the respondents have good knowledge of the health impact created by climate change, indicating that they have sufficient knowledge and are aware of the matter.

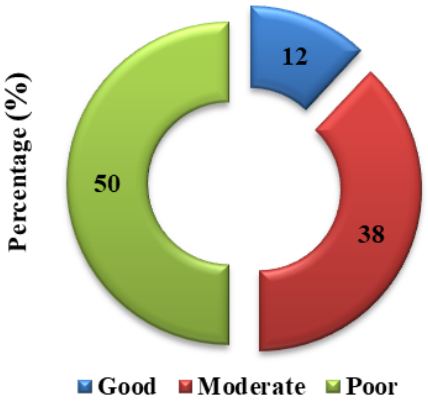


**Figure 10.** Knowledge level about climate-induced health impact.

Through the survey, we found out that the knowledge level of a large group of people in that area about the health impact of climate change is very low. They do not know the serious impact of climate change on their health. A housewife said, "For the past few years, our domestic animals have been getting new diseases that were not seen before. We do not know whether these are due to climate change. But now the air temperature has increased since before, the amount of salt in the seawater has also increased, and the rainfall is not so much; although it is little, it is untimely. But it is true that now our diseases are a little more prevalent than before. Which is ruining our health day by day.

### 3.3.3. Level of People's Capability to Cope with Health Problems

Figure 11 shows the ability to cope with health problems in the Kuakata municipality area, where we consider the percentage of respondents at different levels of coping capability, including high, very high, moderate, low, and very low. According to the survey, most of the respondents (50%) have low coping capability with health problems, indicating they were unable to overcome their health-related issues. Additionally, 30% of the respondents in Kuakata municipalities have moderate coping capability with health problems, while 11% of the respondents have very high coping capability, which indicates that they are financially resilient. Moreover, 8% of the respondents possess a high capability to cope with health problems, and only 1% of the respondents have a very low capability to cope with health problems.

Many of the respondents said that they no longer can deal with disasters because all resources have been wiped out due to frequent cyclones and other natural disasters. Additionally, due to a lack of cyclone shelters, everyone must seek refuge in local hotels. At that time, everyone is physically and mentally exhausted. Based on this data, it can be concluded that the people of the Kuakata municipality area lack sufficient support for their health and well-being due to poor conditions.

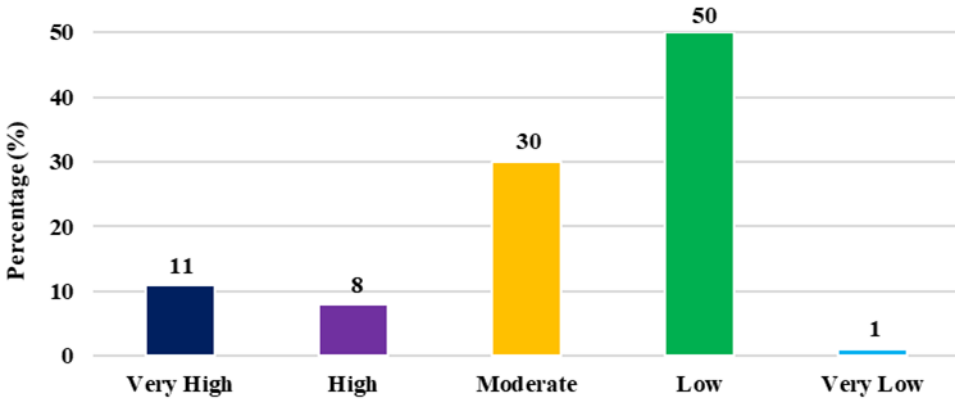


**Figure 11.** Level of people's capability to cope with health problems.

### 3.3.4. Level of Existing Governmental Resource to Minimize Health Impact

Figure 12 displays the percentage of respondents' perceptions of the current governmental (govt.) resources available to mitigate health impacts in Kuakata municipalities, where we classified these resources into three levels: poor, moderate, and good. According to the respondents, the majority (69%) reported that the existing government resources were of very poor quality. Additionally, 21% of the respondents indicated moderate levels of government resources, while only 10% pointed out good-quality resources to minimize health impacts.

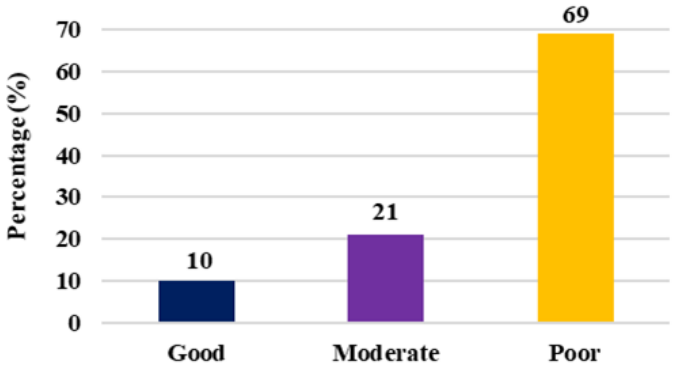


**Figure 12.** Level of existing govt. resource to minimize health impact.

A large portion of the respondents said that there are no government resources available to mitigate the health impacts they face. They hardly get assistance from the government during various disasters. A fisherman said, "We receive very little support from the chairman or members, which was insufficient for us during the calamity. All of us are supposed to get one card, but the chairman divides a single card among two or four of us. But this one card is supposed to be received individually by only one fisherman. During cyclones, we are provided with a one-time allocation of half a kilogram of muri and one liter of water, which is inadequate.

The data indicates a low level of existing government resources to mitigate health impacts. Consequently, the people of Kuakata municipality have not received sufficient government support to address their health issues.

### 3.3.5. Indigenous Knowledge Practices to Mitigate Health Problems

According to the data, 92% of respondents reported practicing indigenous knowledge to mitigate their health problems, while only 8% of the respondents did not practice indigenous knowledge to mitigate health problems. Most of the respondents faced health-related problems; using indigenous knowledge, they could recover from the health impact. Most of the respondents state that they do not have access to good healthcare here. Although there is a hospital in the area, good treatment is not available. Rather, the Upazila health complex is quite far away and lacks essential equipment, medicine, and consistent medical staff. Consequently, many of us rely on indigenous knowledge to address health issues. In the study area, people said, "We do not get medical services here, and even if available, we cannot receive them due to financial constraints. So, we have been practicing indigenous remedies for health problems since childhood. For instance, we use sea salt water for fever and headache problems, not only for children but also for adults. Using it for bathing is advantageous, and people have been doing this for

generations". This indicates that many respondents depend on indigenous knowledge to manage their health-related issues.

#### 3.3.6. Attending Health Awareness-Related Training Programs

According to the survey data, most of the respondents (90%) did not attend any health awareness-related training programs. A housewife in Islampur village of the Kuakata municipalities, said, "There are no health awareness-related training programs in our area. They have attended such a training program only once in my entire life, which was several years ago. But we should also do this training so that we can be more aware. Conversely, only 10% of respondents reported that they had participated in health awareness-related training programs. Based on interviews, it has been determined that the Kuakata municipalities require more health awareness-related training programs so that they get awareness-related training. As a result, the people of the Kuakata municipalities would be more aware of their health and health-related issues.

## 4. Conclusions

The study has been accomplished to assess the people's perception of climate change impact on human health at Kuakata municipality. Temperatures are increasing at an accelerated rate daily. The field survey revealed that a staggering 96% of households reported an increase in temperature. The study area is particularly vulnerable to two primary natural hazards: cyclones and salinity. A yield loss of 48% has been documented because of elevated salinity levels. According to the findings of the study, 55% of the respondents attributed the most significant yield loss to drought. The study area provides a clear illustration of the severity problem and its impact on agricultural production. The yield loss has resulted in a multitude of health complications for the affected individuals. The study area is also experiencing malnutrition due to losses in fish and livestock production. In the study area, 41% of respondents reported experiencing hypertension and skin disease due to salinity. It has been documented that pregnant women are susceptible to hypertension and urinary tract infections due to salinity. The occurrence of premature birth and child skin diseases has been demonstrated to be associated with issues related to salinity. In the study area, approximately 72% of respondents reported a lack of access to food and clean water in cyclone shelters. During the field visit, it was determined that most respondents resided in mud houses, which have been demonstrated to be suboptimal in terms of their ability to withstand various types of disasters. The extent of awareness regarding the health implications of climate change in this region is minimal. According to the findings of the study, 69% of the respondents expressed dissatisfaction with the quality of government resources in the area, with the majority reporting that they do not have access to adequate healthcare services in the region. A significant proportion of the population, constituting 90% of the sample, reported that they had not undergone any formal health-related training. To summarize the constraints, it is imperative to implement a multifaceted approach encompassing awareness-raising initiatives, training programs, volunteer involvement, the refinement of management systems, and the provision of adequate education. This comprehensive strategy is essential for fostering a resilient community that can combat health challenges. Despite the unlikelihood of halting the occurrence of climate change, effective planning, preparedness, adaptation techniques, management, and the combined contributions of humans have the potential to mitigate its impact on human health and enhance community resilience.

### *Policy and Practice Implications*

This study recommends a coordinated, community-based adaptation and risk management strategy to reduce climate-induced vulnerabilities in Kuakata municipality. Emphasis should be placed on climate-resilient housing by providing subsidized structural upgrades such as elevated plinths, reinforced roofs, improved ventilation, and sanitation while prioritizing low-income and high-risk households and expanding multipurpose cyclone shelters within walking distance. Integrating climate-informed early warning systems with community health education is essential to enhance awareness of climate-sensitive diseases, safe water and sanitation practices, and timely responses to extreme weather and disease outbreaks. Community health resilience can be further strengthened by improving access to emergency care through mobile clinics, cyclone-proof shelters equipped with basic medical facilities, and community-managed emergency health funds linked to micro-insurance schemes. Government-supported, inclusive multipurpose cyclone and health shelters with livestock protection, trained local health workers, and transparent digital beneficiary systems are necessary to ensure equitable service delivery. Moreover, the formal integration of validated indigenous health knowledge into primary healthcare under clear safety protocols and professional supervision can improve affordability and cultural acceptability. Finally, gender-

sensitive, ward- and home-based health awareness programs led by trained female volunteers are crucial for overcoming social and mobility barriers and strengthening household-level adaptive capacity to climate risks.

## Author Contributions

M.N.B.N.: investigation, formal analysis, funding acquisition, data curation, resources, software, validation, visualization, writing—original draft; S.S.: investigation, formal analysis, methodology, data curation, resources, visualization, writing—original draft; M.S.: investigation, methodology, conceptualization, resources, software, validation, visualization, supervision, writing—original draft, review & editing; M.R.: data curation, resources, visualization, writing—review & editing; I.Z.O.: data curation, resources, visualization, writing—review & editing; K.I.: resources, visualization; M.A.R.: investigation, writing—reviewing & editing; R.S.: supervision, writing—review & editing. All authors have read and agreed to the published version of the manuscript.

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## Institutional Review Board Statement

The ethical review and approval process was not applicable to this study, as the research was classified as empirical social science research. The authors of this study have also been recognized as practitioners of non-destructive and computer-based analysis approaches that didn’t result in harm to any humans or animals.

## Informed Consent Statement

Informed consent was obtained verbally from all subjects involved in the study. A total of 130 respondents were interviewed in person, 45 participants were involved in three focus groups, and 10 key informant interviews (KIIs) were conducted for the study.

## Data Availability Statement

Data will be made available upon request.

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## Conflicts of Interest

The authors declare no conflict of interest. Given their editorial roles, Rajib Shaw (Editor-in-Chief) and Md. Shamsuzzoha (Editorial Board Member) had no involvement in the peer review of this paper and had no access to information regarding its peer-review process. Full responsibility for the editorial process of this paper was delegated to another editor of the journal.

## Use of AI and AI-Assisted Technologies

The authors used Copilot to improve their ideas to review the Fourth Assessment Report of the IPCC 2001 and The Health Sector Assessment (HSA) in detail to understand climate variability and change how it expected to elevate morbidity and mortality risks for the introduction part. The DeepL was used to correct sentences and remove grammatical mistakes. All content was reviewed and approved by the corresponding author using a

licensed Microsoft 365 subscription product. After using the tools, the authors reviewed and edited the content as needed and took full responsibility for the content of the published article.

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