

Addressing Data Challenges for Understanding Climate-Sensitive Diseases in Bangladesh: Evidence from Systematic Review and Government Data Repository

--Manuscript Draft--

Manuscript Number:	PONE-D-23-35790
Article Type:	Research Article
Full Title:	Addressing Data Challenges for Understanding Climate-Sensitive Diseases in Bangladesh: Evidence from Systematic Review and Government Data Repository
Short Title:	Climate change induced diseases in Bangladesh
Corresponding Author:	Md Iqbal Kabir, PhD University of Dhaka Dhaka, Dhaka District BANGLADESH
Keywords:	Climate sensitive disease, government data respiratory, systematic review, Bangladesh.
Abstract:	<p>Abstract</p> <p>Background: Understanding the effects of climate change on health outcomes is crucial for effective policy formulation and intervention strategies. However, in low- and middle-income countries like Bangladesh, the true extent of these negative effects remains unexplored due to data scarcity. This study aims to assess available evidence on climate change-related health outcomes in Bangladesh, to compare it with actual occurrences, and to explore challenges related to climate change and health data.</p> <p>Methods: We first conducted a systematic review to summarize the climate-sensitive diseases examined in existing literature in Bangladesh. The review results were then compared with over 2.8 million samples from the government's data repository, representing reported cases of climate-sensitive diseases during 2017-2022. This comparison aimed to identify discrepancies between the diseases currently occurring in Bangladesh related to climate change and available knowledge through existing research. Additionally, we also explored the limitations of the data recorded in the government data repository.</p> <p>Results: The available literature in Bangladesh covered only a fraction of the total climate-sensitive diseases recorded in the government data repository. We also explored several challenges related to available data in the government repository, which includes inadequate collection of patients' comprehensive socio-demographic information and the absence of a unique patient identifier.</p> <p>Conclusion: The findings highlight the pressing requirement to address data challenges in comprehending climate-sensitive diseases in Bangladesh. It is imperative to prioritize the digitalization of the healthcare system and implement a unique patient identification number to facilitate accurate tracking and analysis of health-related data.</p>
Order of Authors:	<p>Md Iqbal Kabir</p> <p>Dewan Mashrur Hossain</p> <p>Md. Toufiq Hassan Shawon</p> <p>Md. Mostaufred Ali Khan</p> <p>Md Saiful Islam</p> <p>As Saba Hossain</p> <p>Md. Nuruzzaman Khan</p>
Opposed Reviewers:	
Additional Information:	
Question	Response
Financial Disclosure	The author(s) received no specific funding for this work.

Enter a financial disclosure statement that describes the sources of funding for the work included in this submission. Review the [submission guidelines](#) for detailed requirements. View published research articles from [PLOS ONE](#) for specific examples.

This statement is required for submission and **will appear in the published article** if the submission is accepted. Please make sure it is accurate.

Funded studies

Enter a statement with the following details:

- Initials of the authors who received each award
- Grant numbers awarded to each author
- The full name of each funder
- URL of each funder website
- Did the sponsors or funders play any role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript?

Did you receive funding for this work?

Competing Interests

Use the instructions below to enter a competing interest statement for this submission. On behalf of all authors, disclose any [competing interests](#) that could be perceived to bias this work—acknowledging all financial support and any other relevant financial or non-financial competing interests.

This statement is **required** for submission and **will appear in the published article** if the submission is accepted. Please make sure it is accurate and that any funding sources listed in your Funding Information later in the submission form are also declared in your Financial Disclosure statement.

View published research articles from

The authors have declared that no competing interests exist.

[PLOS ONE](#) for specific examples.

NO authors have competing interests

Enter: *The authors have declared that no competing interests exist.*

Authors with competing interests

Enter competing interest details beginning with this statement:

I have read the journal's policy and the authors of this manuscript have the following competing interests: [insert competing interests here]

* typeset

Ethics Statement

Enter an ethics statement for this submission. This statement is required if the study involved:

- Human participants
- Human specimens or tissue
- Vertebrate animals or cephalopods
- Vertebrate embryos or tissues
- Field research

Write "N/A" if the submission does not require an ethics statement.

General guidance is provided below. Consult the [submission guidelines](#) for detailed instructions. **Make sure that all information entered here is included in the Methods section of the manuscript.**

We conducted an analysis of deidentified secondary data obtained from the MoHFW of Bangladesh. As a result, ethical approval was not deemed necessary.

Format for specific study types

Human Subject Research (involving human participants and/or tissue)

- Give the name of the institutional review board or ethics committee that approved the study
- Include the approval number and/or a statement indicating approval of this research
- Indicate the form of consent obtained (written/oral) or the reason that consent was not obtained (e.g. the data were analyzed anonymously)

Animal Research (involving vertebrate animals, embryos or tissues)

- Provide the name of the Institutional Animal Care and Use Committee (IACUC) or other relevant ethics board that reviewed the study protocol, and indicate whether they approved this research or granted a formal waiver of ethical approval
- Include an approval number if one was obtained
- If the study involved *non-human primates*, add *additional details* about animal welfare and steps taken to ameliorate suffering
- If anesthesia, euthanasia, or any kind of animal sacrifice is part of the study, include briefly which substances and/or methods were applied

Field Research

Include the following details if this study involves the collection of plant, animal, or other materials from a natural setting:

- Field permit number
- Name of the institution or relevant body that granted permission

Data Availability

Authors are required to make all data underlying the findings described fully available, without restriction, and from the time of publication. PLOS allows rare exceptions to address legal and ethical concerns. See the [PLOS Data Policy](#) and [FAQ](#) for detailed information.

No - some restrictions will apply

<p>A Data Availability Statement describing where the data can be found is required at submission. Your answers to this question constitute the Data Availability Statement and will be published in the article, if accepted.</p> <p>Important: Stating 'data available on request from the author' is not sufficient. If your data are only available upon request, select 'No' for the first question and explain your exceptional situation in the text box.</p> <p>Do the authors confirm that all data underlying the findings described in their manuscript are fully available without restriction?</p>	
<p>Describe where the data may be found in full sentences. If you are copying our sample text, replace any instances of XXX with the appropriate details.</p> <ul style="list-style-type: none"> • If the data are held or will be held in a public repository, include URLs, accession numbers or DOIs. If this information will only be available after acceptance, indicate this by ticking the box below. For example: <i>All XXX files are available from the XXX database (accession number(s) XXX, XXX).</i> • If the data are all contained within the manuscript and/or Supporting Information files, enter the following: <i>All relevant data are within the manuscript and its Supporting Information files.</i> • If neither of these applies but you are able to provide details of access elsewhere, with or without limitations, please do so. For example: <p><i>Data cannot be shared publicly because of [XXX]. Data are available from the XXX Institutional Data Access / Ethics Committee (contact via XXX) for researchers who meet the criteria for access to confidential data.</i></p> <p><i>The data underlying the results presented in the study are available from (include the name of the third party</i></p>	<p>The data supporting the findings of this study are accessible through MoHFW of Bangladesh but are not publicly available. Researchers interested in accessing the dataset can do so by submitting a research proposal to MoHFW, similar to the process we followed to obtain the dataset for this study. The dataset can be accessed at http://www.mohfw.gov.bd. Interested researchers can apply to access the datasets at http://www.mohfw.gov.bd.</p>

<p><i>and contact information or URL).</i></p> <ul style="list-style-type: none"> • This text is appropriate if the data are owned by a third party and authors do not have permission to share the data. <p>* typeset</p>	
<p>Additional data availability information:</p>	<p>Tick here if the URLs/accession numbers/DOIs will be available only after acceptance of the manuscript for publication so that we can ensure their inclusion before publication.; Tick here if your circumstances are not covered by the questions above and you need the journal's help to make your data available.</p>

Emily Chenette

Editor-in-Chief

PLoS ONE

Subject: Submission of Manuscript - "Addressing Data Challenges for Understanding Climate-Sensitive Diseases in Bangladesh"

Dear Emily Chenette,

I am pleased to submit our manuscript titled "Addressing Data Challenges for Understanding Climate-Sensitive Diseases in Bangladesh: Evidence from Systematic Review and Government Data Repository" for publication consideration in the PLoS ONE. This study aims to assess available evidence on climate change-related health outcomes in Bangladesh, to compare it with actual occurrences reported in the government data repository, and to explore challenges related to climate change and health data.

We first conducted a systematic review to summarize the climate-sensitive diseases examined in existing literature in Bangladesh. The review results were then compared with over 2.8 million samples from the government's data repository, representing reported cases of climate-sensitive diseases during 2017-2022. This comparison aimed to identify discrepancies between the diseases currently occurring in Bangladesh related to climate change and available knowledge through existing research. Additionally, we also explored the limitations of the data recorded in the government data repository.

We found that the available literature in Bangladesh covered only a fraction of the total climate-sensitive diseases recorded in the government data repository. We also explored several challenges related to available data in the government repository, which includes inadequate collection of patients' comprehensive socio-demographic information and the absence of a unique patient identifier.

The manuscript aligns with PLoS ONE's focus on disseminating high-quality research. We believe our paper would have global appeal and be of interest to your readers.

Thank you for your time and consideration.

Sincerely,

Md Iqbal Kabir

Professor of Epidemiology

Coordinator

Climate Change and Health Promotion Unit (CCHPU)

Health Services Division

Ministry of Health and Family Welfare, Topkhana Road, Dhaka 1000, Bangladesh.

Email: Iqbalkabirdr@gmail.com

Addressing Data Challenges for Understanding Climate-Sensitive Diseases in Bangladesh: Evidence from Systematic Review and Government Data Repository

Md Iqbal Kabir^{1,5}, Dewan Mashrur Hossain¹, Md. Toufiq Hassan Shawon², Md. Mostaufed Ali Khan³, Md Saiful Islam¹, As Saba Hossain¹, Md Nuruzzaman Khan⁴

¹Climate Change and Health Promotion Unit (CCHPU), Health Services Division, Ministry of Health and Family Welfare, Topkhana Road, Dhaka 1000, Bangladesh.

²Management Information System (MIS), Directorate General of Health Services, Ministry of Health and Family Welfare, Mohakhali, Dhaka - 1212, Bangladesh.

³Maternal and Child Health Division, icddr,b, Mohakhali, Dhaka - 1212, Bangladesh.

⁴Dept. of Population Science, Jatiya Kabi Kazi Nazrul Islam University, Trishal, Mymensingh - 2220, Bangladesh.

⁵Department of Disaster Science and Climate Resilience, University of Dhaka, Dhaka-1000, Bangladesh.

Short running title: Climate change induced diseases in Bangladesh

Corresponding author

Md Iqbal Kabir

Professor of Epidemiology

Coordinator

Climate Change and Health Promotion Unit (CCHPU)

Health Services Division

Ministry of Health and Family Welfare, Topkhana Road, Dhaka 1000, Bangladesh.

Email: Iqbalkabirdr@gmail.com

Addressing Data Challenges for Understanding Climate-Sensitive Diseases in Bangladesh: Evidence from Systematic Review and Government Data Repository

Abstract

Background: Understanding the effects of climate change on health outcomes is crucial for effective policy formulation and intervention strategies. However, in low- and middle-income countries like Bangladesh, the true extent of these negative effects remains unexplored due to data scarcity. This study aims to assess available evidence on climate change-related health outcomes in Bangladesh, to compare it with actual occurrences, and to explore challenges related to climate change and health data.

Methods: We first conducted a systematic review to summarize the climate-sensitive diseases examined in existing literature in Bangladesh. The review results were then compared with over 2.8 million samples from the government's data repository, representing reported cases of climate-sensitive diseases during 2017-2022. This comparison aimed to identify discrepancies between the diseases currently occurring in Bangladesh related to climate change and available knowledge through existing research. Additionally, we also explored the limitations of the data recorded in the government data repository.

Results: The available literature in Bangladesh covered only a fraction of the total climate-sensitive diseases recorded in the government data repository. We also explored several challenges related to available data in the government repository, which includes inadequate collection of patients' comprehensive socio-demographic information and the absence of a unique patient identifier.

Conclusion: The findings highlight the pressing requirement to address data challenges in comprehending climate-sensitive diseases in Bangladesh. It is imperative to prioritize the digitalization of the healthcare system and implement a unique patient identification number to facilitate accurate tracking and analysis of health-related data.

Keywords: Climate sensitive disease, government data respiratory, systematic review, Bangladesh.

Background

Climate Change, including rising temperature and extreme weather events like cyclone and floods, poses a significant global health threat [1]. The impacts are far-reaching, leading to forced displacement, malnutrition and increased incidence of diseases such as dengue, diarrhoea, and pneumonia [2]. Additionally, climate change has established links to mental health issues, like anxiety and depression [3, 4]. The effects are particularly severe in Low- and Middle-Income Countries (LMICs) due to limited resources and inadequate infrastructure for coping with erratic weather and disasters [5].

Bangladesh, a LMIC located in South Asia, ranks seventh among countries most vulnerable to climate change due to its vast coastal area, high population density and high poverty rate [6]. There is an estimate that one in every seven people in Bangladesh will be displaced by 2050 because of climate change, particularly due to sea level rise [7]. This would result in approximately loss of 11% of the country's total land area and migration of up to 18 million people [7]. These long-term consequences compounded the regular occurrence of adverse climate events, for instances, floods, cyclone, flash floods and landslides that affect Bangladesh almost every year [8].

Adverse climate change events pose serious risks to disease outbreaks in Bangladesh. Sixty percent of global cyclone-related deaths in the past 20 years occurred there, either because of casualty due to cyclone and/or post-cyclonic adverse health outcomes [7]. Moreover, at least 117 million population will be at risk of facing malaria by 2070, potentially rising to 147 million under high emission situation [9]. Other climate sensitive diseases, including dengue, chikungunya, kala-azar, and cholera, are increasingly prevalent in Bangladesh [6, 9]. These pose risk to achieving the Universal Health Coverage (UHC), a key focus of Bangladesh's Sustainable Development Goals. Inadequate funding, infrastructure, resources, logistic, and services in the healthcare system further compound the risk of climate change impact [10].

The Government of Bangladesh formulated a Climate Change Strategy and Action Plan in 2008, later updated in 2009, to tackle climate-sensitive diseases [11]. This plan recognized the importance of establishing a surveillance system to monitor both existing and emerging diseases associated with climate change, as well as strengthening the resilience of health systems for the future. However, the effectiveness of these initiatives is primarily hindered by the lack of relevant data. Currently available data mostly originates from small-scale regional studies, which often focus on a few specific outcomes and yield conflicting findings [12-15]. Although the government-initiated data collection and utilization efforts through District Health Information System 2 (DHIS 2) in 2009, the usability and coverage of this data remain largely unexplored. As a result of these complexities, there are limited knowledge regarding the climate change-related health outcomes in Bangladesh as compared to the global perspective, and the true extent of climate-sensitive diseases in the country remains unknown. This hampers the development of effective policies and programs to address the health impacts of climate change. To overcome this limitation, we conducted a mixed-methods study to explore the climate-sensitive diseases reported in existing literature in Bangladesh and compared them with the reported scenarios of relevant data in the government data repository. Furthermore, we examined the challenges associated with reporting climate change and related diseases data in the government data repository.

Methods

We undertook a comprehensive mixed-method study, incorporating a systematic review of existing studies conducted in Bangladesh, along with an analysis of government data repository. A detailed description of each component is presented below.

Systematic review

We performed a systematic review and adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for meta-analyses of observational studies. We included studies that were relevant and accessible on the impact of climate change on health.

Searches

We conducted a systematic literature search in initially December 2022 and later updated it in July 2023. Total of six databases (Medline, Embase, Maternity and Infant Care, Scopus, PsycINFO, and CINHL) were searched. Additional searches were conducted in the Google and Google Scholar and reference lists of included papers. The full search strategy and results are presented in the Supplementary Table 1-6. The search strategy was developed including the keywords related to climate change related terms combined using the Bolen operator “OR”. These include climate change OR environmental disaster OR environmental degradation OR environmental issues OR adaptation or vulnerable community OR vulnerabilities. The study focused on Bangladesh as the setting. To combine the search results, we used another Boolean operator, "AND". We did not impose any restrictions on the diseases related to climate change to encompass all climate-sensitive diseases recorded in the existing evidence.

Study selection

Two authors (Khan MN and Islam MS) performed a comprehensive review of all articles, adhering to the inclusion and exclusion criteria outlined in Table 1. Initially, they conducted a screening of titles and abstracts, and articles selected during this stage underwent full-text review. Any disagreements were resolved through discussions between the two authors, and involvement of senior author (Kabir MI) was sought when necessary. Online platforms such as COVIDENCE, EndNote, and Zoom Online meetings were utilized for conducting this review.

Table 1: Inclusion and exclusion criteria used to select the study to explore the effects of climate change on health outcomes in Bangladesh

Characteristics	Inclusion criteria	Exclusion criteria
Language	Both Bengali and English	None
Study design	All study design	None
Place of studies	Bangladesh	Other than Bangladesh
Publication status	Published from January 2000 to July 2023	Published before January 2000

Paper	Peer reviewed published journal articles	Conference presentation, editorials, letters to the editor, commentaries, review paper, and symposium proceedings
Outcome	Any health-related outcomes	Other than health-related outcomes

Data extraction

A data extraction template was developed, tested, and refined prior to final data compilation. Two authors (Khan MN and Islam MS) independently extracted relevant information from the selected studies, including authors' names, study design, sample size, study setting, and specific categories of climate-sensitive diseases. Any discrepancies between the data collectors were resolved through discussions, with involvement from the senior author (Kabir MI) if needed.

Quality assessment of included studies

The quality assessment of the included studies was conducted using the modified Newcastle-Ottawa Scale [16]. The scale encompassed specific criteria for cross-sectional (n=26), case-control (n=2), cohort studies (n=2), qualitative studies (n=3), and Randomized Control Trial (n=1). Authors reviewed the articles and marked an “*” for each criterion met. The scores were then summed up and categorized into three groups: high quality study (if the study achieved over 75% of the total allocated score), moderate quality (if the study achieved 50 to 74% of the total allocated score), and low quality (if the study achieved below 50% of the total allocated score). The majority of the studies were of moderate quality (n=27), followed by low quality (n=6) and only one high-quality study (n=1) (Supplementary table 7-11).

Study variables

All adverse events related to climate change were considered as study variables. These events include temperature, rainfalls, floods, droughts, and cyclones. A full list of climatic events can be found in the search strategy presented in the Supplementary table 1-6.

Outcome variables

Several adverse health outcomes were considered as outcome variables. The full list of outcome variables is available in the fourth column of the Table 1.

Exploration of respiratory health data from governmental database

The government of Bangladesh in 2009 started recording real-time healthcare service utilization data for every patient admitted in to the divisional, district, and upazila level government hospitals through DHIS 2 platform. Both aggregated and individual-level data were recorded, but for our analysis, we focused solely on the individual-level data and climate sensitive diseases as per International Classification of Diseases-10 (ICD-10). The data was collected by authorized personnel, including statisticians and medical staff, using a web-based platform during the provision of treatment to patients. The information was automatically stored in the National Health Information System database.

Analysis

The heterogeneity of the included studies through systematic review precluded quantitative analysis of the data. We therefore used narrative synthesis to summarize the findings of all retrieved studies. We used descriptive statistics to explore the quantitative data recorded in the DHIS 2. Stata version 15.1/MP (StataCorp, College Station, Texas USA) was used for statistical analysis.

Results

Study selection

A total of 1420 papers were initially identified through a comprehensive search across six databases, supplemented by additional identification of 11 papers via Google, Google Scholar, and a review of reference lists from the selected articles. After removal of duplicate entries, a refined list of 1367 unique articles was obtained. Upon screening of titles and abstracts based on predefined inclusion and exclusion criteria, 886 articles were excluded, as depicted in Figure 1. This left 315 articles for full-text review, during which 245 articles were excluded. Ultimately, 70

articles were included in this review, of which 36 were discarded reviewing the study design and finally 34 studies were included in qualitative synthesis.

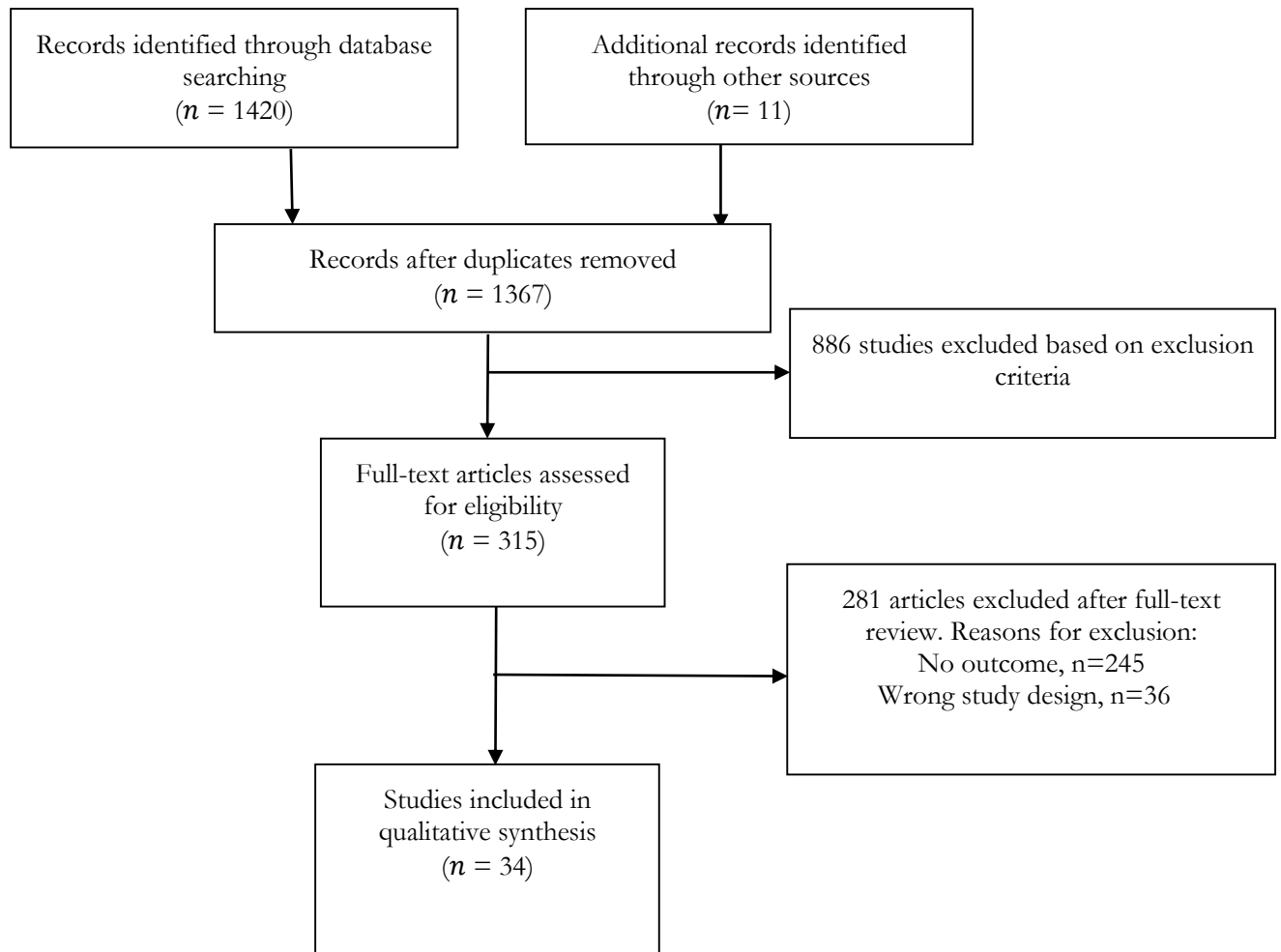


Figure 1: PRISMA flow diagram illustrating the study selection process covering effects of climate change on diseases in Bangladesh.

An abridged representation of all the papers included in the current research is available in Supplementary Table 12. A summary of the key findings derived from these papers is presented in Table 2. A majority of the selected study were cross-sectional (n=26), followed by case-control study (n=2), cohort study (n=2), and Randomized control trial (n=1). Moreover, three of the included studies were qualitative. Majority of these studies conducted at the regional level (n=29).

A substantial portion of these studies considered climate induced communicable diseases, including Diarrhea (n=15), Dengue (n=4), Cholera (n=5), Malaria (n=4), and Pneumonia (n=4). Non-communicable diseases, including cardiovascular diseases (n=3), Hypertension (n=4), Urinary-Tract Infections (n=2), and Malnutrition (n=2) were also considered in few studies.

Table 2: Summary of the existing literature in Bangladesh for the period 2000-2022 covering adverse climate events and climate sensitive diseases.

	Author's, Year of publication	Study type	Study location	Outcome
Communicable diseases (CDs)	Hu et al. 2014 [17]	Regional	Dhaka	Dengue
	Hossain et al. 2019 [18]	National	Bangladesh	Dengue
	Sharker et al. 2020 [19]	Regional	Dhaka	Dengue
	Lorah et al. 2022 [20]	National	Bangladesh	Cholera
	Ishimura et al. 2008 [21]	Regional	Dhaka	Cholera
	Rheman et al. 2009 [22]	Regional	Matlab	Cholera
	Yunus et al. 2018 [23]	Regional	Matlab	Cholera
	Yunus et al. 2014 [24]	Regional	Matlab	Diarrhoea
	Mollah et al. 2014 [25]	Regional	Dhaka	Diarrhoea
	Mollah et al. 2014 [26]	Regional	Dhaka	Asthma
	Grembi et al. 2022 [27]	Regional	Gazipur, Kishoreganj, Mymensingh, Tangail	Diarrhoea
	Nguyen et al. 2022 [13]	Regional	Gazipur, Kishoreganj, Mymensingh, Tangail	Diarrhoea
	Armstrong et al. 2007 [14]	Regional	Patients visiting (ICDDR, B), Dhaka	Non-Cholera Diarrhoea
	Hashizume et al. 2010 [28]	Regional	Rangamati district hospital	Malaria
	Adegboye et al. 2020 [29]	Regional	UHC, Rajasthali, Rangamati	Malaria
	Tong et al. 2020 [30]	Regional	Matlab	Pneumonia
	Ibrahim et al. 2018 [12]	National	Bangladesh	Malaria, Diarrheal Disease, Enteric Fever, Encephalitis, Pneumonia, and Bacterial Meningitis.
	Hashizume et al. 2016 [31]	Regional	Mymensingh, Tangail, Gazipur, Pabna, Jamalpur, Khulna, Panchagar, Rajshahi, and Sirajganj.	Kala-Azar
	Nurhamim 2020 [32]	National	Bangladesh	Skin Infection, Pneumonia, Respiratory Infection, Mosquito-Borne Illnesses, Hepatitis A Or E Virus Infection.

	Rahman et al. 2016 [33]	Regional	Bagerhat, Barguna, Cox's Bazar, Faridpur, Khulna, Satkhira, and Sirajganj	Dengue, Malaria, Diarrhea, and Pneumonia
	Ashrafuzzaman and Furini 2019 [34]	Regional	Shyamnagar Upazila	Dysentery, Skin Diseases and Diarrhea
	Parr et al. 2019 [35]	Regional	North-western mainland region of Bangladesh	Fever, Diarrhea, Jaundice, Typhoid, Acute Respiratory Infections and Gastrointestinal Diseases
	Shi et al. 2022 [36]	Regional	Gaibandha	Skin Diseases and Diarrhea
Non-communicable diseases	Rutherford et al. 2016 [37]	Regional	Koyra, (Khulna)	Hypertension, Cardiovascular Diseases, Kidney Diseases, Malnourished
	Khan et al. 2019 [38]	Regional	Mathbaria ,Zianagar , Mongla	Cardiovascular, Diarrhea, Abdominal pain, Gastric ulcer, Dysentery, Skin Diseases, Typhoid
	Chowdhury et al. 2017 [39]	Regional	Dacope, Batiaghata, Paikghaccha	High blood pressure, Hypertension
	Khan et al. 2016 [40]	Regional	Dacope, Khulna	Hypertension
	Siddique et al. 2016 [41]	Regional	Chakaria	Eclampsia, Hypertension, Cardiovascular Diseases, Cancer
Maternal Health Issues	Rashid and Michaud 2000 [42]	Regional	Manikganj, Dhaka	Gota and Chulkani, Perineal Rashes, Cramps and Urinary-Tract Infections, Fever, Diarrhea and Jaundice
	Haq A et al. 2021 [43]	National	Bangladesh	Fertility
	Dalal et al. 2019 [44]	Regional	Khaliakhuri (Netrakona)	Malnutrition and Anemia, Urinary Tract Infections.
Mental Health Issues	Kabir 2018 [15]	Regional	Chattogram, Cox's Bazar, Rangamati, Bandarban ,Khagrachhar	Depression, Frustration, and Suicide Tendency
CDs & NCDs	Baernighausen et al. 2021 [45]	Regional	Bhola slum, Dhaka	Fever, Diarrhoea, Cough, Psychological Trauma, Body Aches
	Ashraf and Faruk 2018 [46]	Regional	Dhaka	Diarrhea and Cholera, Sweating, Feeling Thirsty, Discomfort, Headache, Stomach Aches, Prickly-Heat, Getting Easily Irritated, Feeling Sluggish, Weakness and

				Dehydration, Cold and Fever, Irritation in Skin, Loss of Concentration
--	--	--	--	--

Exploration from quantitative data extracted from the government data respiratory

Background characteristics of the respondents

The climate sensitive diseases data were found to be recorded 516 healthcare facilities and we included all in the analysis. The district (secondary administrative unit of Bangladesh) wise distribution of these healthcare facilities along wise risk of climate change events is presented in Figure 2. The dataset comprising 2,865,365 records of individuals who reported any form of climate-sensitive diseases within the timeframe spanning from January 2017 to November 2022. The climate-sensitive diseases were classified using the ICD-10, as presented in the Supplementary Table 13. The distribution of samples across different years revealed that the highest number of cases was recorded in 2019, accounting for 22.50% of the total dataset. This was followed by 2022, which accounted for 20.54%, and 2018, with 18.88% of the cases (Table 2).

Table 2: Distribution of the data according to the years reported

Year	Number	Percentage
2017	358897	12.53
2018	540928	18.88
2019	644597	22.50
2020	201699	7.04
2021	530626	18.52
2022	588618	20.54

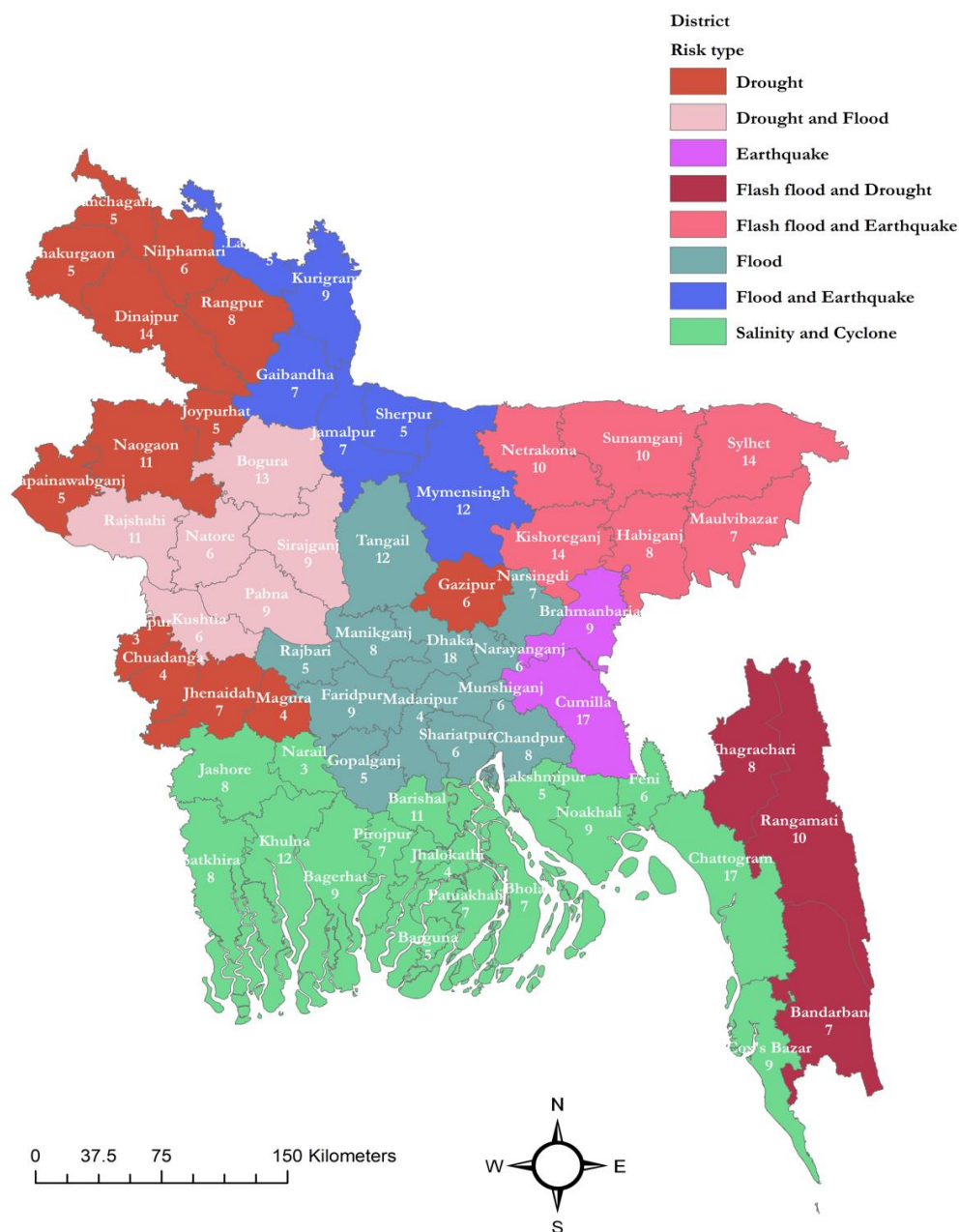


Figure 2: Distribution of climate vulnerable areas with number of healthcare facilities from where DHIS 2 data were recorded.

Sample characteristics

The distribution of the analyzed sample across socio-demographic characteristics of the respondents is presented in Table 3. We found a higher prevalence of climate-sensitive diseases among female (55.82%) following male (44.16%). Under-five aged children were found to have the highest incidence of climate-sensitive diseases, comprising 33.13% of all cases. Additionally, respondents aged 5-19 years accounted for 13.93% of cases, followed by those aged 20-29 years

(14.89%) and 30-39 years (11.94%). In terms of geographical distribution, the Rajshahi division exhibited the highest occurrence of climate-sensitive diseases at 18.27%, followed by Chattogram at 17.60%, Dhaka at 16.14%, and Khulna at 14.71%.

Table 3: Basic characteristics of the climate sensitive diseases patients

Characteristics	Number	Percentage
Sex		
Male	1264534	44.16
Female	1598525	55.82
Third gender	677	0.02
Patient's Age		
<5	836131	33.13
5-19	351594	13.93
20-29	375742	14.89
30-39	301356	11.94
40-49	235917	9.35
50-59	190663	7.56
60-69	140560	5.57
70-79	64775	2.57
≥80	26676	1.06
Division		
Barishal	212755	7.43
Chattogram	504309	17.6
Dhaka	462374	16.14
Khulna	421573	14.71
Mymensingh	182203	6.36
Rajshahi	523542	18.27
Rangpur	312883	10.92
Sylhet	221577	7.73
Unrecognised	24150	0.84

Distribution of climate sensitive diseases

We observed a total of 510 cases of climate-sensitive diseases in the quantitative data we analysed, as indicated in the Supplementary Table 13. These cases represented nearly 94% of the 540 climate-sensitive diseases summarized in the ICD-10 climate-sensitive diseases mapping. Out of the 510 recorded climate-sensitive diseases, 143 diseases were responsible for 90.66% of the total occurrences. We reclassified these diseases into 14 categories based on their similar types which are presented in Figure 3 and Supplementary Table 14 and 15. District wise distribution of these diseases are presented in Supplementary Table 16. Diarrhea and gastroenteritis of presumed infectious origin were the most prevalent climate-sensitive diseases, accounting for 28.51% of the

cases. Other significant diseases included various forms of pneumonia (18.88%) and anxiety disorders, panic disorders, generalized anxiety disorders, and others (13.15%). Additionally, urinary tract infections (7.87%), cholera (3.03%), and typhoid fever (3.27%) were frequently reported climate-sensitive diseases.

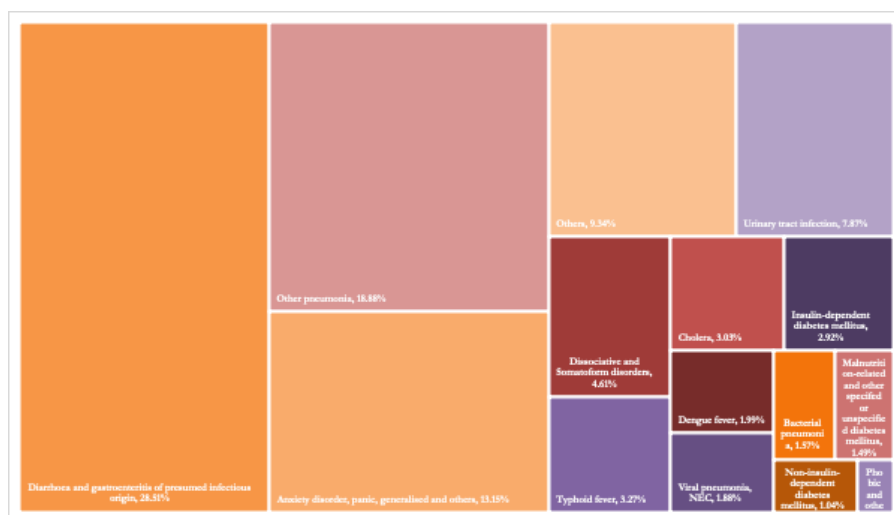


Figure 3. Major diseases related to climate change in Bangladesh over the year 2017-2022.

The distribution of these more prevalent diseases was examined on a yearly basis, and the findings are presented in Table 4. In general, the prevalence of most of these diseases showed an increase in 2019, except for cholera, which exhibited an increase in 2017.

Table 4. Years-wise distribution of most prevalent climate-sensitive diseases in Bangladesh, year 2017-2022.

Climate Sensitive Diseases	2017		2018		2019		2020		2021		2022	
	n	%	n	%	n	%	n	%	n	%	n	%
Cholera	24499	28.21	18034	20.77	12466	14.36	0	0.00	16947	19.52	14894	17.15
Typhoid fever	19732	21.07	22526	24.05	23459	25.04	0	0.00	12081	12.90	15870	16.94
Diarrhoea and gastroenteritis of presumed infectious origin	74008	9.06	180089	22.05	201528	24.67	0	0.00	206373	25.26	154910	18.96
Dengue fever	414	0.72	1295	2.27	26756	46.84	850	1.49	3799	6.65	24009	42.03
Insulin-dependent diabetes mellitus	8506	10.15	12238	14.60	14949	17.84	11003	13.13	14551	17.36	22553	26.91
Non-insulin-dependent diabetes mellitus	2290	7.70	3601	12.10	5065	17.02	4541	15.26	5295	17.79	8966	30.13
Malnutrition-related and other specified or unspecified diabetes mellitus	4152	9.70	5907	13.80	7778	18.17	6463	15.10	7422	17.34	11080	25.89
Phobic and other anxiety disorders	2086	16.58	2167	17.23	2741	21.79	1855	14.75	1986	15.79	1744	13.86
Anxiety disorder, panic, generalised and others	47584	12.63	69952	18.56	77013	20.44	47945	12.72	57882	15.36	76438	20.29
Dissociative and Somatoform disorders	21297	16.13	25579	19.38	26624	20.17	16857	12.77	18192	13.78	23462	17.77
Viral pneumonia, NEC	10229	18.97	10060	18.65	11309	20.97	4042	7.49	9841	18.25	8454	15.67
Bacterial pneumonia	7383	16.43	9631	21.43	10151	22.59	2765	6.15	4887	10.87	10121	22.52
Other pneumonia	77921	14.40	89183	16.48	122484	22.64	50363	9.31	95487	17.65	105646	19.52
Urinary tract infection	25399	11.26	39244	17.40	48834	21.65	28681	12.72	33117	14.69	50240	22.28
Others	33397	12.48	51422	19.22	53440	19.97	26334	9.84	42767	15.98	60231	22.51

Note: Row percentage was presented in the table

Discussion

This study aimed to examine the climate-sensitive diseases documented in the existing literature and to compare them with the government data repository, while also exploring challenges related to recording diseases associated with climate change. Our findings indicate that the current literature in Bangladesh only covers a fraction of the total climate change-related diseases recorded in the government data repository. Moreover, the government-recorded data have several limitations, posing significant challenges for policymakers and program developers in effectively addressing climate-sensitive diseases. Therefore, there is an urgent need to improve efforts in reporting and documenting all climate-sensitive diseases, along with the development of comprehensive policies and programs to address them effectively.

The existing literature in Bangladesh primarily focuses on the impact of climate change on specific health outcomes. For example, dengue outbreaks are extensively studied as a major climate change-related disease in Bangladesh [17-19]. Weather-related factors like temperature, humidity, and rainfall play a critical role in the proliferation of vectors, viruses, and ecological factors associated with dengue [15, 18, 36]. While individuals of all age groups are susceptible to the disease, women, children, and the elderly have been identified as more vulnerable populations. Conversely, cholera is commonly observed in children, with heatwaves, rainfall, temperature, and water pH level being reported as underlying factors [15, 36]. Childhood diarrheal diseases are also linked to climate change, particularly during flooding, due to the impact on safe water and sanitation [22, 39, 41].

Furthermore, climate-sensitive diseases contribute significantly to the loss of Disability Adjusted Life Years (DALYs) among children. Malaria, pneumonia, and malnutrition-related outcomes like stunting, wasting, and underweight have been identified as prominent factors [27, 42]. Selected studies have also documented the loss of DALYs related to other adverse climate-sensitive diseases [34, 35]. In addition to these direct adverse health outcomes, numerous studies establish a link between climate change and an increase in adult health conditions such as high blood pressure,

cardiovascular diseases, abdominal pain, gastric ulcers, dysentery, skin diseases, and typhoid, often resulting from water salinity [17, 29, 31].

Some studies also explore the relationship between climate change and maternal health issues, including menstrual hygiene and the use of maternal healthcare services [42]. During floods, the crowded shelter conditions pose challenges for proper menstruation management, particularly among women and adolescent girls [33]. Adverse climate events like cyclones, floods, and droughts reduce the utilization of maternal healthcare services, including antenatal, delivery, and postnatal care, which contributes to an increased risk of pregnancy complications and maternal mortality [22, 40, 41].

Despite the valuable insights provided by the research on the adverse health effects of climate change in Bangladesh, it is crucial to acknowledge that the available studies only cover a fraction of the total climate-sensitive diseases recorded globally and within the government data repository, as reported in this study. This limitation primarily arises from the lack of reliable and accessible data on climate change and its impact on health [19]. The scarcity of such data hinders the accurate identification and quantification of specific health risks associated with climate change within the country [23]. Furthermore, the research capacity and resources in Bangladesh, as a LMICs, face inherent limitations. Insufficient funding, inadequate infrastructure, and a shortage of skilled researchers pose significant obstacles to conducting comprehensive studies [33]. These constraints can compromise the quality and breadth of research conducted, as well as the ability to gather and analyse data on a larger scale [19]. Moreover, the intricate and multifaceted nature of climate change and its complex relationship with health necessitate collaborative efforts across disciplines and sectors. Bangladesh's high population density and diverse geographical settings further contribute to the challenges faced in capturing the heterogeneity of health impacts across different regions and population groups. Socioeconomic disparities, cultural variations, and limited access

to healthcare further complicate the landscape of conducting research on climate change and health in the country.

Although a national-level initiative is in place to collect real-time healthcare data related to climate changes and other health issues, it has some significant limitations. The major drawback of the current data collection is that while basic patient demographics, such as age and gender, are recorded, vital information such as education, occupation, household wealth, and specific factors contributing to these diseases, remain uncollected. This lack of comprehensive data hampers our understanding of the diseases and our ability to accurately identify high-risk groups. Furthermore, the absence of patients' community characteristics, including place of residence and geographic region, further limits our knowledge of areas prone to climate-sensitive diseases. This may lead to an overrepresentation of disease prevalence in certain districts and divisional facilities while neglecting others. To improve the initiative's effectiveness, it is crucial to expand data collection efforts to include a more diverse set of healthcare facilities. Additionally, efforts should be made to gather more detailed patient information, such as education, occupation, and household wealth, to gain a better understanding of the social and economic factors influencing disease prevalence. Moreover, incorporating patients' community characteristics, such as place of residence and geographic region, would enable us to identify specific regions at higher risk for climate-sensitive diseases. This knowledge can aid in targeted interventions and resource allocation to address the health challenges effectively.

Another significant limitation is the absence of unique identification numbers to track the health status of patients. This creates challenges in accurately counting patients, as individuals may be transferred between healthcare facilities or change facilities entirely, resulting in duplicate counts. As a result, the exact number of patients with climate-sensitive diseases remains largely unknown. Additionally, inadequate coverage is a major issue in the current data reporting system. The data

recorded in DHIS 2 only represents a subset of healthcare facilities, leaving a significant portion of facilities at the upazila to divisional level unaccounted for. Furthermore, a considerable number of patients with climate-sensitive diseases seek treatment at non-hospital settings, where only aggregate counts are recorded, lacking individual-level data. To overcome these challenges, there is a pressing need for comprehensive improvements in data collection and reporting systems, particularly at the policy and program level.

This study demonstrates several notable strengths as well as a few limitations. One notable strength of this research lies in its ability to offer a comprehensive understanding of climate change and its adverse health impacts. This is achieved through a systematic review and analysis of data from the government data repository, allowing for a comprehensive exploration of climate-sensitive diseases. Strict quality control measures ensured while collecting this data. Additionally, the utilization of the ICD-10 criteria for classifying these diseases and the investigation of the most prevalent conditions provides valuable insights for policymakers. These findings facilitate evidence-based policymaking and the development of targeted programs to address climate-sensitive diseases in Bangladesh.

However, an important limitation of this study is the inability to provide summarized findings due to the inconsistent nature of the available literature. Moreover, the absence of unique patient identification numbers within the dataset poses challenges in distinguishing individuals reported multiple times across various healthcare facilities. Additionally, the lack of relevant data hampers the ability to assess the likelihood of disease occurrence based on respondents' characteristics. Despite these limitations, this study still holds significant value in enhancing the understanding of the prevalence of climate-sensitive diseases in Bangladesh and informing appropriate response strategies. To address these limitations, it is crucial to enhance the data collection process by incorporating additional patient characteristics, capturing information on the reasons for disease

occurrence, and obtaining community-level data. Furthermore, the implementation of unique identification numbers for accurate patient tracking is essential. Expanding the scope of data collection to include a wider range of healthcare facilities is also imperative. By addressing these limitations and obtaining more precise and comprehensive data on climate-sensitive diseases in Bangladesh, policymakers and researchers can develop evidence-based interventions and formulate effective policies to adapt and mitigate the impact of these diseases on public health.

Conclusion

The existing studies conducted in Bangladesh have only examined a fraction of the total climate-sensitive diseases that are reported in the government data repository. These studies have also failed to yield conclusive findings due to limitations such as small sample sizes and restricted coverage of specific geographical areas. Additionally, while the government data repository covers a wide range of climate-sensitive diseases, there are several identified issues that render it less usable. These include the absence of basic patient characteristics, which hinders comprehensive analysis, and the lack of individual identification, which increases the possibility of reporting the same patient multiple times. These limitations pose challenges for the country in developing evidence-based policies and programs related to climate-sensitive diseases. Given the escalating and ongoing concerns regarding this issue, it is crucial to place greater emphasis on data collection, data analytics and available research.

Declarations

Ethics approval: We conducted an analysis of deidentified secondary data obtained from the MoHFW of Bangladesh. As a result, ethical approval was not deemed necessary.

Consent for publication: Not applicable

Availability of data and material: The data supporting the findings of this study are accessible through MoHFW of Bangladesh but are not publicly available. Researchers interested in accessing the dataset can do so by submitting a research proposal to MoHFW, similar to the process we

followed to obtain the dataset for this study. The dataset can be accessed at <http://www.mohfw.gov.bd>. Interested researchers can apply to access the datasets at <http://www.mohfw.gov.bd>.

Competing interests: None

Funding: The authors received a seed fund from UNICEF Bangladesh under which this study was partially funded.

Authors' Contribution: Kabir MI and Khan MN developed the study concept. Khan MMA and Khan MN performed data analysis. Khan MN write the first draft of the manuscript along with Islam MS. Hossain DM, Shawon TH, Hossain AS, Kabir MI and Khan MN critically reviewed the manuscript. All authors approved the final version of the manuscript.

Acknowledgements: We acknowledge the support of Climate Change and Health Promotion Unit of the Ministry of Health and Family Welfare, Government of Bangladesh, where this study was conducted and UNICEF Bangladesh for partial funding.

References

1. Parling I. Human Rights and Climate Change: Are States Violating the Right to Life by Not Cutting Emissions? The Swedish Institute of International Affairs, Ui Paper,(3). 2021.
2. Salm L, Nisbett N, Cramer L, Gillespie S, Thornton P. How climate change interacts with inequity to affect nutrition. *Wiley Interdisciplinary Reviews: Climate Change*. 2021;12(2):e696.
3. Iffat Mahmud WAR, Md Rafi Hossain, . *International Development in Focus: Climate Afflictions* World Bank, Dhaka, Bangladesh. , 2021.
4. Cianconi P, Betrò S, Janiri L. The impact of climate change on mental health: a systematic descriptive review. *Frontiers in psychiatry*. 2020;11:74.
5. Hallegatte S, Rozenberg J. Climate change through a poverty lens. *Nature Climate Change*. 2017;7(4):250-6.
6. Mehedi Al Amin. *Climate Change The Business Standard* 2021.
7. How the Climate Crisis is impacting Bangladesh [Internet]. 2021.
8. Sultana P, Thompson PM. Adaptation or conflict? Responses to climate change in water management in Bangladesh. *Environmental Science & Policy*. 2017;78:149-56.
9. Climate Change and Health Promotion Unit. *Climate Change and Health in Bangladesh* Climate Change and Health Promotion Unit, People's Republic of Bangladesh, Health Service Division, Ministry of Health and Family Welfare. : 2022.
10. World Health Organization UNFCCC. *Climate Change and Health Country Profile-2015*, Bangladesh Geneva, Switzerland. : World Health Organization, United Nations Framework Convention on Climate Change, 2015.
11. Ministry of Environment and Forests. *Bangladesh Climate Change Strategy and Action Plan 2009* Dhaka, Bangladesh. : Ministry of Environment and Forests, Government of the People's Republic of Bangladesh. , 2009.

12. Chowdhury FR, Ibrahim QSU, Bari MS, Alam MJ, Dunachie SJ, Rodriguez-Morales AJ, et al. The association between temperature, rainfall and humidity with common climate-sensitive infectious diseases in Bangladesh. *PloS one*. 2018;13(6):e0199579.
13. Grembi JA, Nguyen AT, Riviere M, Heitmann GB, Patil A, Athni TS, et al. Influence of climatic and environmental risk factors on child diarrhea and enteropathogen infection and predictions under climate change in rural Bangladesh. *medRxiv*. 2022:2022.09.26.22280367. doi: 10.1101/2022.09.26.22280367.
14. Hashizume M, Armstrong B, Hajat S, Wagatsuma Y, Faruque AS, Hayashi T, et al. Association between climate variability and hospital visits for non-cholera diarrhoea in Bangladesh: effects and vulnerable groups. *Int J Epidemiol*. 2007;36(5):1030-7. Epub 20070730. doi: 10.1093/ije/dym148. PubMed PMID: 17664224.
15. Kabir SMS. Psychological health challenges of the hill-tracts region for climate change in Bangladesh. *Asian journal of psychiatry*. 2018;34:74-7. doi: <https://dx.doi.org/10.1016/j.ajp.2018.04.001>.
16. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. 2000.
17. Banu S, Hu W, Guo Y, Hurst C, Tong S. Projecting the impact of climate change on dengue transmission in Dhaka, Bangladesh. *Environment international*. 2014;63:137-42. doi: <https://dx.doi.org/10.1016/j.envint.2013.11.002>.
18. Hsan K, Hossain MM, Sarwar MS, Wilder-Smith A, Gozal D. Unprecedented rise in dengue outbreaks in Bangladesh. *The Lancet Infectious Diseases*. 2019;19(12):1287. doi: <https://dx.doi.org/10.1016/S1473-3099%2819%2930616-4>.
19. Rahman KM, Sharkar Y, Rumi RA, Khan MUI, Shomik MS, Rahman MW, et al. An association between rainy days with clinical dengue fever in dhaka, bangladesh: Findings from a hospital based study. *International journal of environmental research and public health*. 2020;17(24):1-9. doi: <https://dx.doi.org/10.3390/ijerph17249506>.

20. Kruger SE, Lorah PA, Okamoto KW. Mapping Climate Change's Impact on Cholera Infection Risk in Bangladesh. medRxiv. 2022. doi: <https://dx.doi.org/10.1101/2022.06.09.22276227>.
21. Matsuda F, Ishimura S, Wagatsuma Y, Higashi T, Hayashi T, Faruque ASG, et al. Prediction of epidemic cholera due to *Vibrio cholerae* O1 in children younger than 10 years using climate data in Bangladesh. *Epidemiology and infection*. 2008;136(1):73-9. doi: <https://dx.doi.org/10.1017/S0950268807008175>.
22. Sharker MAY, Rheman S, Hossain S, Mahmud ZH, Islam MS, Uddin AMK, et al. Effects of local climate variability on transmission dynamics of cholera in Matlab, Bangladesh. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 2009;103(11):1165-70. doi: <https://dx.doi.org/10.1016/j.trstmh.2009.04.016>.
23. Wu J, Yunus M, Ali M, Escamilla V, Emch M. Influences of heatwave, rainfall, and tree cover on cholera in Bangladesh. *Environment international*. 2018;120:304-11. doi: <https://dx.doi.org/10.1016/j.envint.2018.08.012>.
24. Wu J, Yunus M, Streatfield PK, Emch M. Association of climate variability and childhood diarrhoeal disease in rural Bangladesh, 2000-2006. *Epidemiology and infection*. 2014;142(9):1859-68. doi: <https://dx.doi.org/10.1017/S095026881300277X>.
25. Molla NA, Mollah KA, Ali G, Fungladda W, Shipin OV, Wongwit W, et al. Quantifying disease burden among climate refugees using multidisciplinary approach: A case of Dhaka, Bangladesh. *Urban Climate*. 2014;8:126-37. doi: 10.1016/j.uclim.2014.02.003.
26. Molla NA, Mollah KA, Fungladda W, Ramasoota P. Multidisciplinary household environmental factors: Influence on DALYs lost in climate refugees community. *Environmental Development*. 2014;9(1):1-11. doi: 10.1016/j.envdev.2013.09.006.
27. Nguyen AT, Grembi JA, Riviere M, Heitmann GB, Hutson WD, Athni TS, et al. Influence of climate and environment on the efficacy of water, sanitation, and handwashing interventions

on diarrheal disease in rural Bangladesh: a re-analysis of a randomized control trial. medRxiv. 2022:2022.09.25.22280229. doi: 10.1101/2022.09.25.22280229.

28. Haque U, Hashizume M, Glass GE, Dewan AM, Overgaard HJ, Yamamoto T. The role of climate variability in the spread of malaria in bangladeshi highlands. PloS one. 2010;5(12):e14341. doi: <https://dx.doi.org/10.1371/journal.pone.0014341>.

29. Emeto TI, Adegboye OA, Rumi RA, Khan M-UI, Adegboye M, Khan WA, et al. Disparities in Risks of Malaria Associated with Climatic Variability among Women, Children and Elderly in the Chittagong Hill Tracts of Bangladesh. International Journal of Environmental Research and Public Health. 2020;17(24):9469. PubMed PMID: doi:10.3390/ijerph17249469.

30. Hossain MZ, Tong S, AlFazal Khan M, Hu W. Impact of climate variability on length of stay in hospital for childhood pneumonia in rural Bangladesh. Public Health. 2020;183:69-75. doi: <https://dx.doi.org/10.1016/j.puhe.2020.03.014>.

31. Dewan A, Hashizume M, Rahman M, Abdullah AYM, Corner RJ, Shogib M, et al. Environmental change and kala-azar with particular reference to Bangladesh. Kala Azar in South Asia: Springer; 2016. p. 223-47.

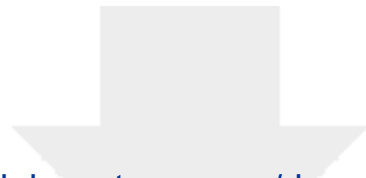
32. Nurhamim M. Causes & impacts of flood disaster in Bangladesh: Special focus on public health. Indian Journal of Public Health Research and Development. 2020;11(12):181-9. doi: <https://dx.doi.org/10.37506/ijphrd.v11i12.13236>.

33. Kabir MI, Rahman MB, Smith W, Lusha MA, Milton AH. Climate change and health in Bangladesh: a baseline cross-sectional survey. Global health action. 2016;9:29609. doi: <https://dx.doi.org/10.3402/gha.v9.29609>.

34. Ashrafuzzaman M, Furini GL. Climate change and human health linkages in the context of globalization: An overview from global to southwestern coastal region of Bangladesh. Environment International. 2019;127:402-11. doi: <https://doi.org/10.1016/j.envint.2019.03.020>.

35. Haque MR, Parr N, Muhidin S. Parents' healthcare-seeking behavior for their children among the climate-related displaced population of rural Bangladesh. *Social science & medicine* (1982). 2019;226:9-20. doi: <https://dx.doi.org/10.1016/j.socscimed.2019.02.032>.
36. Hossain B, Shi G, Ajiang C, Sarker MNI, Sohel MS, Sun Z, et al. Impact of climate change on human health: evidence from riverine island dwellers of Bangladesh. *International journal of environmental health research*. 2022;32(11):2359-75. doi: <https://dx.doi.org/10.1080/09603123.2021.1964447>.
37. Talukder MRR, Rutherford S, Phung D, Islam MZ, Chu C. The effect of drinking water salinity on blood pressure in young adults of coastal Bangladesh. *Environmental pollution* (Barking, Essex : 1987). 2016;214:248-54. doi: <https://dx.doi.org/10.1016/j.envpol.2016.03.074>.
38. Chakraborty R, Khan KM, Dibaba DT, Khan MA, Ahmed A, Islam MZ. Health Implications of Drinking Water Salinity in Coastal Areas of Bangladesh. *International journal of environmental research and public health*. 2019;16(19). doi: <https://dx.doi.org/10.3390/ijerph16193746>.
39. Scheelbeek PFD, Chowdhury MAH, Haines A, Alam DS, Hoque MA, Butler AP, et al. Drinking Water Salinity and Raised Blood Pressure: Evidence from a Cohort Study in Coastal Bangladesh. *Environmental health perspectives*. 2017;125(5):057007. doi: <https://dx.doi.org/10.1289/EHP659>.
40. Scheelbeek PFD, Khan AE, Mojumder S, Elliott P, Vineis P. Drinking Water Sodium and Elevated Blood Pressure of Healthy Pregnant Women in Salinity-Affected Coastal Areas. *Hypertension* (Dallas, Tex : 1979). 2016;68(2):464-70. doi: <https://dx.doi.org/10.1161/HYPERTENSIONAHA.116.07743>.
41. Rasheed S, Siddique AK, Sharmin T, Hasan AMR, Hanifi SMA, Iqbal M, et al. Salt Intake and Health Risk in Climate Change Vulnerable Coastal Bangladesh: What Role Do Beliefs and Practices Play? *PloS one*. 2016;11(4):e0152783. doi: <https://dx.doi.org/10.1371/journal.pone.0152783>.

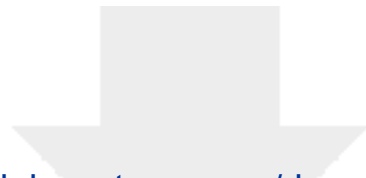
42. Rashid SF, Michaud S. Female adolescents and their sexuality: notions of honour, shame, purity and pollution during the floods. *Disasters*. 2000;24(1):54-70.
43. Chen M, Atiqul Haq SM, Ahmed KJ, Hussain AHMB, Ahmed MNQ. The link between climate change, food security and fertility: The case of Bangladesh. *PloS one*. 2021;16(10):e0258196. doi: <https://dx.doi.org/10.1371/journal.pone.0258196>.
44. Abdullah ASM, Dalal K, Halim A, Rahman AF, Biswas A. Effects of Climate Change and Maternal Morality: Perspective from Case Studies in the Rural Area of Bangladesh. *International journal of environmental research and public health*. 2019;16(23). doi: <https://dx.doi.org/10.3390/ijerph16234594>.
45. Nayna Schwerdtle P, Baernighausen K, Karim S, Raihan TS, Selim S, Baernighausen T, et al. A Risk Exchange: Health and Mobility in the Context of Climate and Environmental Change in Bangladesh—A Qualitative Study. *International Journal of Environmental Research and Public Health*. 2021;18(5):2629.
46. Ashraf SA, Faruk M. Children's perspective on adaptation to heat waves and heavy precipitation in Dhaka, Bangladesh. *Procedia Engineering*. 2018;212:768-75. doi: 10.1016/j.proeng.2018.01.099.



[Click here to access/download](#)

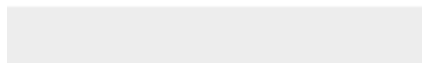
Supporting Information
Supplementary File_Final.docx

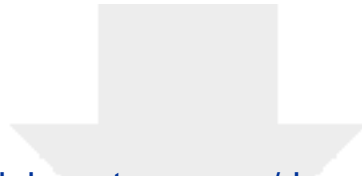




[Click here to access/download](#)

Supporting Information
PRISMA_2020_checklist.docx





[Click here to access/download](#)

Supporting Information

PLOSONe_Clinical_Studies_Checklist-2.docx

