

Review

Public Health Impact and Health System Preparedness within a Changing Climate in Bangladesh: A Scoping Review

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Abstract: Bangladesh, one of the most disaster-prone countries in the world is also severely exposed to climate change (CC) impacts with a multitude of health complexities. Health adaptation to CC is thus a serious issue in Bangladesh, but not explored properly from a health system and policy environment perspective. In order to address this gap and provide a holistic picture of the overall scenario, this scoping review explores CC impacts on the population health in Bangladesh and discusses the policy environment and health system preparedness against such climatic challenges. A total of 28 articles were reviewed following Arksey and O'Malley's scoping review framework. A "5-point scale" was devised to assess CC integration in the health sector Operational Plans (OPs). Though the country made significant progress in different health indicators, poverty and income inequality have kept marginal communities out of many health provisions. There are four major stakeholders in the health system. The government sector is handicapped by poor governance, bureaucratic processes, and staff shortages; and primarily focuses on the public sector only. National Health Policy (NHP) governs the health system through 29 sectoral OPs, that put CC as a major cross-cutting issue. About 25% of the OPs have fully integrated CC and other OPs have significant CC co-benefits. In Bangladesh CC was linked to increased morbidity and mortality, diarrhea, cholera, skin problems, respiratory infections, malaria, dengue, kala azar, pre-eclampsia, and hypertension. Significant research gaps exist on child health, migrant health, and mental health. Integration of research evidence into policy, planning and program design is largely absent. However, prioritizing health for the National Adaptation Plan is an essential step towards establishing a climate-resilient health system.

Keywords: climate change and health; climate resilient health system; health adaptation; health policy; health system in Bangladesh



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1. Introduction

The global average temperature is already 1 °C higher than the pre-industrial baseline, and the Intergovernmental Panel on Climate Change (IPCC) predicted that warming would exceed the Paris Agreement's 1.5 °C limits before the mid-century. Irreversible changes in atmospheric, marine, and terrestrial systems are now more visible than ever due to human-induced climate change [1]. The IPCC Working Group 1 (WG1) in the Sixth Assessment Report (AR6) has drawn a picture of a world impacted by more intense and frequent heat extremes and heavy precipitation events, droughts, cyclones, and sea level rise (SLR), glacier retreat, a reduction in sea ice cover, and permafrost melting [1]. These will disrupt the various aspects of human health, the healthcare system, and public health activities [2]. Climate change, within a very conservative estimate, will increase the global death toll by 250,000 per year by 2030 to 2050, with higher fatalities in low to middle-income countries [3].

Climate change and extremes impact the spread and risk of vector-borne [4], foodborne [5], and waterborne diseases [6], and often result in higher disease prevalence and severity [7], injury [8], and death [9]. Climate change (CC) also impacts population health through

indirect pathways: air and environmental pollution, urbanization, under-nutrition, food, and water insecurity [10]. CC is “the biggest global health threat of the 21st century” [11] and thus, “protecting human health is the “bottom line” of climate change strategies” [12].

Bangladesh is severely exposed to the impacts of CC and was continuously ranked among the top vulnerable countries between 1999 and 2018, according to the Global Climate Risk Index [13]. Thus, health adaptation to CC is crucial for the country and so far, some progress has been made, which reflects in different policies and programs. There is also a Climate Change and Health Promotion Unit (CCHPU) under the Ministry of Health and Family Welfare (MoHFW) to guide CC and health-related research and health sector preparedness [14]. CC has been included in the national health policy as a critical issue, acknowledging that “protecting health from climate change remains a great challenge” [15] (p. 6). Although there is a growing consensus among policy makers and public health advocates regarding the health implication of CC; policy approaches are lagging far behind [16].

So far, several authors have summarized how CC impacts population health in Bangladesh [17]. However, these articles failed to provide a holistic picture of the whole scenario—putting the climatic impact against the existing health system and policy environment. How the health policy has addressed the CC issue and the characteristics of the health system, its capacity, strength and weakness, and strategy towards future health challenges are more or less absent in the overall discourse and only provide a one-sided picture. In this scoping review, we draw an all-inclusive and up-to-date overview of how CC will impact population health in Bangladesh and assess the policy environment and the existing health system’s capacity to support and sustain health and wellbeing against such challenges. The study further made some key suggestions in line with preparing a climate-resilient health system in Bangladesh, that should be relevant to wider international communities and climate vulnerable countries in strengthening national health adaptations.

2. Methods

Scoping reviews have become increasingly popular for research evidence synthesis [18] and are particularly beneficial for topics that are complex, diverse, and not comprehensively processed or reviewed previously [19]. Arksey and O’Malley developed the scoping review standard procedure and methodological framework, which was further modified by Levac et al. and the Joanna Briggs Institute [18]. We carried out this review with Arksey and O’Malley’s 5-stage scoping review framework [20] and conducted the database search on 17 and 18 June 2021.

2.1. Identifying the Research Question

The policy/research question has been developed as per patient/population, intervention, comparison, and outcome (PICO) criteria for database searches [21] and was kept well-defined and broad enough to generate extensive coverage [18].

The question used: How “health adaptation” (I) is planned to address the impact of “climate change on health” (C) to prepare the “health system in Bangladesh” (O+P)?

2.2. Identifying Relevant Studies

We identified the major “Mesh” terms from PubMed ‘mesh directory’ and finalized the keywords from PubMed, google, and Wikipedia. We conducted the PubMed search using “all field search” in query build-up. The structured literature search was carried out in three electronic databases, PubMed, Scopus, and Web of Science. We also did the literature search in the University of Adelaide online library, which proved to be beneficial in assessing literatures from different electronic databases through a single platform. Key words and Mesh terms against the research question are given in Appendix A.

2.3. Study Selection

The search query was refined by limits to language (English), MEDLINE journal, article type (e.g., books and documents, clinical trial, meta-analysis, randomized controlled trial, review, systematic review), humans, and year of publication from 2000 to 2021. Articles that do not relate to the broader scope of the research question, duplicates, non-English language publications, and those published before 2000, were excluded. Appropriate “Boolean Operators” were used during the database search.

2.3.1. Search Result

In the database search, a total of 70 results were gathered from PubMed (36), Scopus (32), and Web of Science (2). We further had 54 results from the University of Adelaide library search, from which 50 articles were selected (2 dissertation papers and 2 news articles were excluded).

2.3.2. Summary of the Results

All search results (120 articles) were entered into EndNote X9 [22] for further analysis. Initially, 27 duplicates were removed, and the remaining 93 articles were analyzed by title to check relevancy with the research topic. We found 43 articles to be non-relevant and thus excluded. The remaining 50 articles were then assessed by title, abstract, and content.

We analyzed the selected articles based on the quality of the article, study design and type, policy relevancy, health system readiness/preparedness-related article, evidence base, and strength of evidence, etc. [23]. The overall database search process was presented through the PRISMA diagram in Figure 1. We finally selected 28 articles for the literature review (Table 1) and excluded 22 articles (Appendix B) with appropriate explanations.

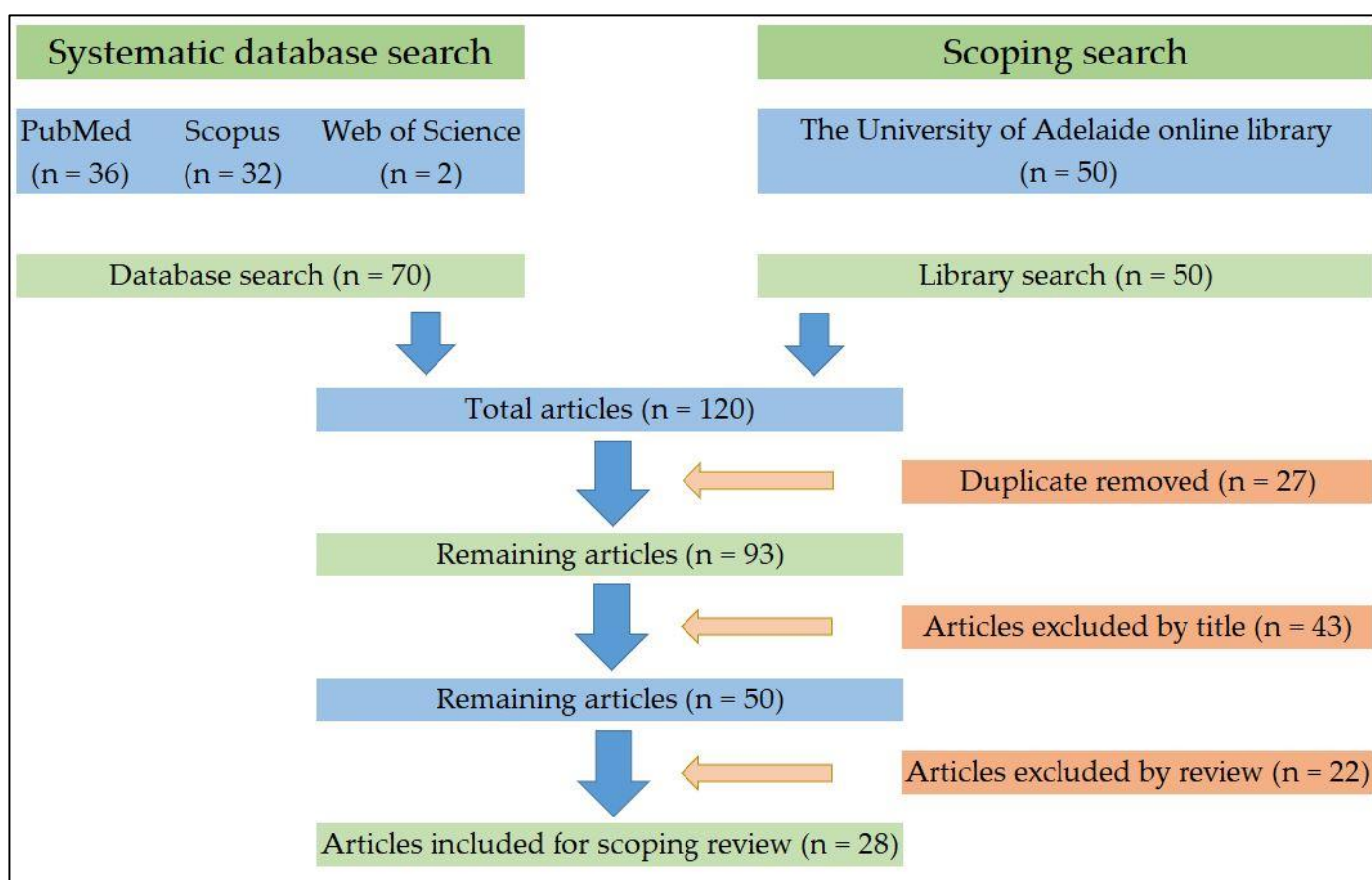


Figure 1. PRISMA diagram summarizing literature search.

Table 1. Included articles for literature review.

First Author; Year	Title	Thematic Topics/Areas	Reference No.
Chowdhury et al., 2018	The association between temperature, rainfall and humidity with common climate-sensitive infectious diseases in Bangladesh.	Impact of climate change on population health—Evidence base	[24]
Das et al., 2019	District level estimates and mapping of prevalence of diarrhoea among under-five children in Bangladesh by combining survey and census data.		[25]
Dewan et al., 2006	Environmental change and kala azar with particular reference to Bangladesh.		[26]
Elahi, 2016	Climate Change and Health Impacts in Bangladesh.		[27]
Haque et al., 2016	Health coping strategies of the people vulnerable to climate change in a resource-poor rural setting in Bangladesh.		[28]
Haque et al., 2014	Use of traditional medicines to cope with climate-sensitive diseases in a resource poor setting in Bangladesh.		[29]
Haque et al., 2019	Parents' healthcare-seeking behavior for their children among the climate-related displaced population of rural Bangladesh		[30]
Huda et al., 2014	Visceral leishmaniasis-associated mortality in Bangladesh: a retrospective cross-sectional study.		[31]
Kabir et al., 2016	Knowledge and perception about climate change and human health: findings from a baseline survey among vulnerable communities in Bangladesh.		[32]
Khan, et al., 2014	Is area affected by flood or stagnant water independently associated with poorer health outcomes in urban slums of Dhaka and adjacent rural areas?		[33]
Koehlmoos et al., 2011	Global health: chronic diseases and other emergent issues in global health.		[34]
Mamun et al., 2021	The COVID-19 pandemic and serious psychological consequences in Bangladesh: A population-based nationwide study.		[35]
Nahar et al., 2014	Increasing the provision of mental healthcare for vulnerable, disaster-affected people in Bangladesh.		[36]
Adams et al., 2013	Innovation for universal health coverage in Bangladesh: a call to action.	Health policy-oriented articles and book chapters	[37]
Fahim et al., 2019	Financing healthcare in Bangladesh: Policy responses and challenges towards achieving universal health coverage.		[38]
Murshid et al., 2020	Hits and misses of Bangladesh national health policy 2011.		[39]
Huq et al., 2019	Confronting climate change in Bangladesh: policy strategies for adaptation and resilience.		[40]
Shafique et al., 2018	Right to health and social justice in Bangladesh: Ethical dilemmas and obligations of state and non-state actors to ensure health for urban poor.		[41]
Yasobant et al., 2020	Toward the Development of an Integrated Climate-Sensitive Disease Surveillance in Southeast Asian Countries: A Situational Analysis.		[42]
Biswas et al., 2018	Assessing the readiness of health facilities for diabetes and cardiovascular services in Bangladesh: a cross-sectional survey.	Health system readiness/preparedness-related articles	[43]
Rahaman et al., 2019	Pathways of Climate-Resilient Health Systems in Bangladesh.		[44]
Rahman et al., 2021	COVID-19 pandemic, dengue epidemic, and climate change vulnerability in Bangladesh: Scenario assessment for strategic management and policy implications.		[45]
Streatfield et al., 2008	Population challenges for Bangladesh in the coming decades.		[46]

Table 1. *Cont.*

First Author; Year	Title	Thematic Topics/Areas	Reference No.
Helldén et al., 2021	Climate change and child health: a scoping review and an expanded conceptual framework.	Scoping/critical review	[47]
Hunter et al., 2021	Scales and sensitivities in climate vulnerability, displacement, and health.		[48]
Rahman et al., 2019	Health consequences of climate change in Bangladesh: An overview of the evidence, knowledge gaps and challenges.		[17]
Hayward et al., 2021	“Seeing with Empty Eyes”: a systems approach to understand climate change and mental health in Bangladesh.	Systematic review	[49]
Schwerdtle et al., 2020	Health and migration in the context of a changing climate: A systematic literature assessment.		[50]

The selected 28 articles worked as the base material for the scoping review. As a part of the scoping review, we further carried out forward and backward searching by collecting references from the selected articles. Major policy documents of the Bangladesh government were assessed from respective government ministry websites (e.g., National Health Policy 2011, Bangladesh Climate Change Strategy and Action Plan 2009, and Annual Reports) and Operational Plans (OPs) through personal communication with colleagues from Program Management and Monitoring Unit (PMMU) of MoHFW.

2.4. Charting the Data

We appraised the content and quality of the articles and grouped them under five major thematic areas/topics for more in-depth analysis. The selected 28 articles represent a good variety of background material ranging across different issues and aspects of public health and the health system concerning CC in Bangladesh (Figure 2).

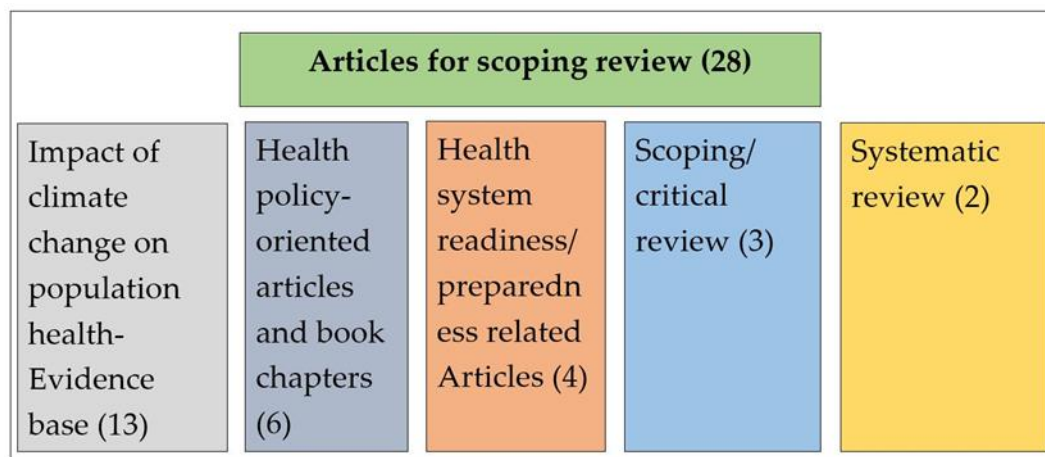


Figure 2. A synthesis of selected articles.

2.5. Collating, Summarizing and Reporting the Results

Here a summarized picture is reported on the overall quality of the selected articles that provides the ground for the detailed scoping review and discussion [20]. There are 13 articles as evidence base (Table 1: serial no. 1–13), giving a concise picture of how CC would impact public health in Bangladesh. These articles covered a range of topics—the impact of temperature, rainfall, humidity on spread of infectious diseases, changes in climate and environment and its impact on water and vector-borne diseases, global change, and the emergence of chronic diseases and how people and different communities are experiencing CC and subsequent impact on health and health-seeking behaviors [24–34]. More recent issues such as mental stress in relation to disaster events [36] with the most recent COVID-19 pandemic situation in Bangladesh had also been covered within the search [35].

We had 4 articles on health system readiness/preparedness against CC in Bangladesh—(Table 1: serial no. 20–23). These articles focused on how the health system is already overburdened by common water, vector-borne, and non-communicable diseases, and how CC would put additional pressure on the system [43,44,46]. One particular study used the COVID-19 pandemic as a central topic and discussed how other water and vector-borne disease epidemics could devastate the country’s fragile health system, including threats from multiple simultaneous calamities [45]. However, none of the articles discussed the issue taking into account the national health policy and Operational Plans.

Six policy-oriented papers and book chapters (Table 1: serial no. 14–19) and three critical/scoping review articles (Table 1: serial no. 24–26) were yielded during the database search. The policy-oriented articles primarily focused on different aspects of the health policy and the health system, notably its achievements and requirements towards achieving universal health coverage [37,39] with some insights into future challenges due to CC [40].

Articles also emphasized the importance of pro-poor health policy [38,41] and establishment of climate-resilient health surveillance throughout the country [42]. The review articles concentrated on children, displacement, vulnerability, and challenges in CC and health discourse in Bangladesh [17,47,48].

We also had two systematic review articles (Table 1: serial no. 27–28) in the database search. One systematic review summarized various aspects of mental health due to CC [49] and another one discussed CC-induced migration and health [50]—two crucial but often neglected issues in the CC and health discourse.

3. Results

We tried to characterize the health system and the policy framework [37–39,41], existing gaps and challenges [17,43,45,46], major climatic drivers in the country, geo-spatial and temporal impact and population-specific vulnerabilities [24–36,47–50], the policy infrastructure, and programs to minimize such adverse effects due to CC and pathways towards a climate resilient health system in Bangladesh [40,42,44], by critically reviewing the selected articles. Additional literature enriched the review with a more detailed and comprehensive picture of the overall scenario and made it relevant to other climate-vulnerable countries. Later, we tried to assess the CC integration in national health policy Operational Plans (OPs) by devising a “5-point scale”. Appropriate health adaptations and alternatives in the context of Bangladesh (and other CC-vulnerable countries) were also discussed.

3.1. Health Gains and Achievements

Bangladesh, since its independence in 1971, made substantial progress through urbanization, communication and infrastructural development, education programs, disaster management, the establishment of primary healthcare facilities at the community level, shifting from agriculture to industry and services-oriented livelihoods, and exporting human resources to foreign countries. Such efforts significantly contributed to the economy, health, and education sectors despite political instability and natural disasters [51–53]. Specific achievements in the health sector can be attributed to the nation’s women-centered, nationally tailored child immunization, oral rehydration therapy, vitamin A supplementation, and family planning programs carried out in a combination with government and non-government organizations within a highly pluralistic health system through adopting a flexible drug policy [39,54].

Country-wide improvements in life expectancy and immunization coverage and a significant decrease in infant and under-five mortality, maternal mortality, and reduction in gender disparity in education are readily visible [37,55,56]. Impressive infrastructural development has been carried out throughout the country—the government has established several medical colleges, district hospitals, sub-district health complexes, and union clinics. The private sector has also emerged as a major health provisioner; privately owned hospitals and diagnostic centers, and NGO-run community health clinics have significantly increased people’s access to the healthcare facilities [14]. Despite this, widespread poverty and persistent income inequality have kept marginal communities out of many health provisions [54,57], creating a health system “black-hole” in Bangladesh [58,59]. Factors such as age, sex, knowledge, and perception towards healthcare are responsible for poor health-seeking behavior; furthermore, low socio-economic status and poverty often limit access to a proper medical facility, medicine intake, and long-term treatment [60–62]. Thus, the overall health scenario has been termed a “health paradox” by the Lancet commission [54].

3.2. Bangladesh’s Pluralistic Health System

Bangladesh’s health system is pluralistic in nature, meaning it is particularly governed by four major stakeholders: the government sector, the private sector, non-government organizations (NGO), and the donor community [63]. Although the government sector has vowed to ensure proper health facilities for its citizens, it suffers from centralized decision making, complex bureaucratic processes, rapid policy changes, severe staff shortages, and

poor governance, etc.; this has created a pathway for the emergence of a for-profit private sector in formal healthcare and the informal sector occupied by (non)-qualified village doctors practicing in Allopathic and/or Ayurvedic, Unani, Homoeopathy, along with traditional faith healers [63]. NGOs with health programs helped create access to health facilities, even in rural and remote areas, primarily targeting women and marginalized communities; Bangladesh achieved some remarkable success thanks to these NGO initiatives in family planning, immunization, nutrition, water supply, and sanitation and hygiene programs. The donor community provides technical expertise and assistance along with development grants and loans, often influencing policy and programmatic priorities [63]. The formal facilities are disproportionately centralized in urban areas; hence, people living in rural areas largely depend on the informal sector. Qualified doctors often practice a dual-role, working in public and private hospitals, leading to a hybrid organizational structure with substantial crossovers [64].

The positive outcome of this pluralistic health system is evident through health gains in different indicators. Locally produced medicines have improved availability, affordability, and accessibility, and supported a diversified workforce in the common interest of serving its population [63]. On the flip side, the system became so complex and dynamic that it went beyond control and started to affect public health adversely. From the policy perspective, the government has no strategy to manage this pluralistic system due to near blindness regarding the formal private and informal sector. The national health policy and programs are concentrated on the public sector only as the sole service provider, whereas in reality, the private sector outpaced the public sector long ago [65]. This ultimately resulted in poor health system governance, absence of data and information availability and sharing, poor service delivery, unnecessary competition among facilities resulting in a higher number of diagnostic tests and over prescribed medicines, overuse and misuse of drugs leading to anti-microbial resistance in the community, etc. [63]. The existing health system in Bangladesh is difficult to define by the World Health Organization (WHO) health system building blocks approach. However, the effort to harness this complex, dynamic, and chaotic system under a common goal of establishing a climate-resilient health system could become highly relevant to many other countries facing climatic adversity and challenges of different scales and magnitudes [63].

3.3. Health Policy and Governance Structure

The WHO describes health policy as a guideline that governs decisions, strategies, and actions within a society to accomplish healthcare goals and thus representative of that country in its perception and approaches to safeguarding the health of its population [66]. National health policy is one of the most vital parts of any country's health system that governs the overall health sector as per local health priorities and thus plans action and allocates a budget as per needs to ensure health access and facilities for its citizens [67,68]. The Ministry of Health and Family Welfare of the Government of Bangladesh is responsible for policy, planning, and managing the health system, which primarily works through the Directorate General of Health Services (DGHS) and the Directorate General of Family Planning (DGFP) [39].

The GoB acknowledges the importance of healthcare for poverty alleviation. It thus has envisaged an equitable health service, gender equality, and health service for all (especially for disabled and marginalized communities) to achieve universal health. The NHP 2011 has three specific objectives, 19 goals, and 39 strategies (governed by 16 principles) for implementation; goal 18 and strategy 34 are explicitly targeted towards CC. The development of health service adaptations in relation to CC was set as principle 15, identifying natural disasters and CC as a potential challenge in doing so [15]. The Bangladesh government runs its health programs under a five-year sector-wide approach (SWAp), currently the 4th Health Population Nutrition Sector Program (4th HPNSP) is under implementation by MoHFW for 2017–2022. The 4th HPNSP further divided the plan into 29 sectoral Operational Plans (OPs)—14 OPs are for Improving Health Services, 11 OPs for Strengthening Health

System (SHS) and the remaining 4 OPs for Strengthening Governance and Stewardship (SGS) [69]. For the implementation of the 4th HPNSP, MoHFW has created two separate divisions—Health System Division (HSD) and Medical Education and Family Welfare Division (ME and FWD)—HSD is responsible for 19 OPs whereas ME and FWD looks after 10 OPs through designated directorates, DGHS and DGFP respectively [69].

There are two opposite extremes that persist in Bangladesh's health system—one of the lowest health system allocations by the government and one of the highest out-of-pocket (OoP) expenditures by people for healthcare spending [38,60]. Health governance is further crippled by inequality, poor institutional management, and a severe manpower shortage in the public health facilities (along with absenteeism), and a disproportionate ratio of skilled professionals (ratio of doctors to nurses to technologists: 1:0.4:0.24). There is less than one bed available for the 1667 population combining both the public and private sector. A weak health information system (HIS) only exists in government facilities. Deteriorating patient–provider relationships are another attribute of the health system in Bangladesh [38,39,55,65].

3.4. Bangladesh's Intrinsic Vulnerability to Climate Change

Bangladesh, the largest and most populous delta in the world, is situated in the Ganges–Brahmaputra river system, and is entrapped between the Himalayas and the Bay of Bengal [54]. The low-lying South Asian country is identified as being the most vulnerable to tropical cyclones, the third most vulnerable to sea level rise, and the sixth most vulnerable to floods due to CC [70]. The country suffered 93 large-scale natural disasters from 1991 to 2000 that claimed the lives of 2 million people [71].

Bangladesh has a biannual cyclone season and, on an average, experiences one severe cyclone every three years [72]. The country suffers from floods each year with 25% of the land becoming inundated; severe floods with a recurring period of 4–5 years devastate about 60% or more of the land area. The northeast part of the country is prone to flash flooding and southern coastal areas are severely damaged by tidal flooding and salinization [73]. Riverbank erosion across the floodplain and salinization of water bodies and agricultural land has become a critical problem in the country, leading to severe food and water insecurity. Drought has been ravaging the northwest part of the country [73].

Bangladesh is experiencing CC faster than the global average. The annual temperature is increasing by 0.3 °C per decade [74], with projections indicating an increase up to 1.8 °C by 2060 and 2.7 °C by 2090s compared to 2010 [75]. Annual rainfall is also projected to intensify by 4% and 7% by 2050 and 2090, respectively, compared to the 1970–2000 mean, with the highest increase during the monsoon, leading to extremes of rainfall [75]. Bangladesh has an SLR of an average 6 mm per year and could have 88 cm SLR by 2100 [76]. With CC, there is a high consensus of an increase in tropical cyclone intensity; about 14% to 69% more land area could become vulnerable to cyclonic activity by 2050 [77]. Flood frequency and intensity, duration, inundation depth, and area are also predicted to increase in upcoming decades [78].

In turn, CC will disrupt the country's socio-economic fabric and damage crop cultivation, fisheries, forestry, and livestock-centered activities and livelihoods, pushing people further into the vicious cycle of poverty [73]. In the most CC-affected southern districts in Bangladesh, more than half of the population are already suffering from varying degrees of food deficit—it was found that these poor and food-insecure communities are the least capable of coping with CC [79]. CC impacts men and women differently. Often older people, women, girls, and children are found to be most vulnerable during and in the aftermath of any disaster events [80].

Natural disasters and CC-induced migration is a hard reality in Bangladesh and is more prevalent in different CC-vulnerable areas [81]. Migration is projected to become even severe due to accelerated SLR [82] and will impose undue pressure on other parts of the country and conflict over limited land and resources [46,73].

3.5. Climate Change Impact on Public Health

Climatic impacts on public health, as best described by Sir Andy Haines, would be in the form of the spread of vector-borne and diarrheal diseases, health outcomes from air pollution and under-nutrition, mortality from health and cold events, and other direct and indirect outcomes due to drought, flood, and storms [34]. These are all prevalent in Bangladesh along with other natural calamities and there is always the possibility of multiple disease outbreaks simultaneously, such as the COVID-19 pandemic and dengue or cholera epidemics, which could devastate the health system [45].

Change in temperature and rainfall along with salinity intrusion is increasing the incidence of diarrheal diseases, especially, in the flood and drought-prone areas and in the coastal districts in Bangladesh [25,44]. An association between temperature increase and diarrhea incidence has already been reported; the country could experience *Escherichia coli* associated with an additional 0.8 million, 1.6 million, and 2.2 million diarrheal cases with 0.8 °C (2016–2035), 1.6 °C (2046–2065), and 2.1 °C (2081–2100) respective temperature increases [83]. People in different climate-vulnerable areas are forced to consume water from contaminated sources—significantly increasing the risk of diarrheal disease [84,85]. Major water-borne diseases, such as cholera, typhoid, and diarrhea from salmonellae, shigella, and *E. coli* were found to increase following heavy rainfall and flooding events [85]. Cholera is endemic in Bangladesh and causes epidemics of flood-associated diarrheal diseases [86]. Cholera shows biannual peaks in Bangladesh—in pre-monsoon and post-monsoon, induced by estuarine coastal processes and terrestrial hydroclimatic variability [87], and is associated with temperature, rainfall, humidity, sea surface temperature, coastal flooding, and El Nino Southern Oscillation (ENSO)—the latter being significantly strengthened in recent years [88–90]. Cyclones, tidal surges, and salinity intrusion increase the risk of *Vibrio cholerae* in more inland areas [91], and the outbreak frequency is likely to increase [92]. Typhoid, another waterborne disease, is associated with temperature rise, and is likely to increase in occurrence in Bangladesh [93]. Short-duration heavy rainfall in the monsoon imposes on the slum dwellers towards various negative health outcomes, such as fever, cold/cough, diarrhea, gastric disease, physical weakness, and poor mental wellbeing [33].

The burden of vector-borne diseases, their geographical distribution and transmission, lifespan and population abundance are greatly affected by weather, climate, and environmental change [94]. Malaria and dengue transmission are associated with temperature, rainfall, humidity, and ENSO variability [95,96]. Malaria incidence has significantly increased in recent decades and about 13.25 million people are suffering within 13 endemic districts in Bangladesh [97]. CC would further increase the distribution of the malaria vector *Plasmodium falciparum* [98]; malaria incidence is associated with temperature and humidity and increases following rainfall events in Bangladesh [24]. Dengue outbreaks have become quite frequent in urban areas in Bangladesh; however, during 2019, dengue cases were reported in rural areas as well. Dengue is severely under-reported in Bangladesh, against a projection of 358,960 cases by WHO, the government officially reported only 7179 cases in 2019 [99]. Dengue is correlated with local climatic parameters and the environment and could become a year-round public health issue in Bangladesh [100]. The growing incidence of *visceral leishmaniasis* (kala azar) has become another concern; with more than 24,000 cases reported per year [101], the vector-borne disease is prevalent in 45 districts in Bangladesh, but more concentrated in Mymensingh district [102,103]. The ethnic tribal communities in Mymensingh were about 17 times more vulnerable to kala azar than the normal population [31]. CC in combination with local land use change can further increase the incidence of kala azar in Bangladesh [26,104].

Zoonotic diseases and their incidence, prevalence and endemicity are also influenced by different climatic parameters and disaster events [17]. Leptospirosis is increasing in urban slum settlements, where overcrowding, poor sanitation, and drainage, waterlogging and a damp environment are common risk factors [105]. Nipah virus encephalitis, another growing public health concern in Bangladesh, is caused by *Pteropus* bats that contain

the Nipah virus [106] and transmission can be triggered due to increased viral shedding through extreme events [107].

Climate variability and change further impact other infectious diseases in Bangladesh—enteric fever, pneumonia, encephalitis, and bacterial meningitis. A positive correlation was found between temperature increase, and enteric fever, and a negative correlation was found with encephalitis, meningitis, and pneumonia. Encephalitis and meningitis incidence increased during low rainfall and were inversely correlated with higher humidity; however, the incidence of enteric fever increased during rainfall [24].

CC impacts health through different direct pathways of slow-onset change in temperature and rainfall [108], and sudden climate extremes such as cyclone-storm surges, floods, lightning, and Nor'westers (locally known as "Kal-Baisakhi") [71]. Bangladesh suffered the brunt of the deadliest cyclone and Nor'wester tornado ever recorded in human history—with a death toll of 300,000 to 500,000 (1970 Bhola cyclone), and 1300 (1989 Manikgonj tornado) lives, respectively [109]. Flood is a major calamity in Bangladesh—the country suffered 78 floods between 1971 and 2014, with a death toll of 41,783 people and USD 12,233 million damage [110]. Along with injury and death, cyclones, tornadoes, and floods can trigger a range of negative health outcomes—infectious diseases, water, food and nutritional insecurity, mental illness, damage to housing and forced displacement, damage to ecosystems and livelihoods, damage to health infrastructure and communication, limited access to health services, dislocation and migration, and loss of jobs and economic crisis [110,111].

Another aspect of direct CC impact will be increased mortality and morbidity related to heat stress [112]; temperature extremes have already been found to be linked with mortality with differential impact based on location, gender, and age group [113]. Short duration heavy rainfall is also increasing in Bangladesh, which is the major cause of landslides and flash floods. More than 727 people died and 1017 were injured during 2000–2018 due to landslides; on average, 19 landslides happen each year with a 4% growth rate [114]. Flash floods have become a growing concern, damaging large areas of standing crops in the preharvest season [115]. Bangladesh suffered one major flash flood in northeast districts in July (55 deaths with 7.2 million people affected) [116] and cyclone Sitrang passed through central southern districts in October of 2022 (24 deaths, till 26 October 2022) [117]. Increased temperature, rainfall and humidity are reported to trigger various food-borne parasitic infections in different subpopulations in the country [27]. Droughts create havoc in affected communities through water insecurity and the incidence of malnutrition, dysentery, diarrheal diseases, and death [84].

Salinity intrusion in coastal drinking water sources has been linked to elevated blood pressure prevalence among the exposed population. Both prehypertension and hypertension prevalence were found to be higher among coastal communities (compared to national rural statistics) who are exposed to and consume slight to moderate saline water [118]. This has been reported as a potential threat to coastal communities in the IPCC Working Group II report's contribution to the AR6 [119]. The study further added that women and those 35 years and older are the at-risk populations for blood pressure anomalies, notably from deep tube wells which are generally perceived as a safe water source from arsenic and fecal coliform contamination and thus pose a threat to future water security. Exposure to saline drinking water has also been positively linked to pre-eclampsia and gestational hypertension among coastal pregnant women [120]. Women from the salinity-affected coastal areas have reported suffering from skin irritation and bleeding in their private parts due to washing clothes in saline water, which ultimately resulted in increased domestic violence and divorce and abandonment [80]. Natural and anthropogenic salinity intrusion has put a large amount of arable land out of production [121] which is likely to be exacerbated by CC and SLR [122], imposing a threat to food and nutritional insecurity and health consequences [123].

Air pollution is another critical but poorly addressed public health issue in Bangladesh, especially in Dhaka, the capital city. Dhaka is infamous for its notoriously poor air quality [124]. Air pollution is one of the most severe environmental risks to health and is

attributed to about one in every nine deaths globally [125]. Poor air is responsible for a range of adverse health consequences [126], with outdoor air pollution having almost double the health burden than indoor air pollution [127]. A recent study by the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr, b) reported a linear increase in incidence of low birth weight and premature birth with a gradual increase in cumulative air pollution exposure among pregnant women in Dhaka city with a gender-differentiated impact and a critical period of pregnancy [128]. Climate change and air pollution are “two sides of the same coin,” [129] and could become particularly dangerous to both the mother and the growing fetus in urban cities [130].

CC-induced impacts and vulnerabilities are often context specific, gender differentiated [80], and greatest in poor and marginalized communities [131]. Women are the primary victims of poverty, malnutrition, economic crisis, environmental pollution, health complexities, insecurity, violence, and political crises during and in the aftermath of any natural disaster, and climatic extremes. Gender differences in deaths are a clear indication of women and children’s vulnerability to natural disasters [132]. Women in rural Bangladesh are often found to be in a malnourished condition and poor health due to child marriage and early childbearing and lack of treatment or ill-treatment, and often experience health crises during and after any disaster [80], and severely suffer from unhygienic reproductive health conditions and gynecological problems [133]. Recently the BBC has reported that women in coastal areas are going through an increased number of uterus removal operations. Dr. Rumana Chowdhury, a Gynecologist from the Friendship Hospital, has said that even women under the age of 35 years are having their uterus removed, which is against the medical ethics. The report further added that the women who went through uterus removal experienced lifelong suffering, weakness, inability to work, and sometimes forced to live a solitary life. The report finally concluded that exposure to the saline environment from an early age could be the reason for such human calamity and suffering among the coastal women. However, there has been no study carried out to explore such incidents [134]. Another recent report has pointed out that saline water is causing increased uterine diseases among coastal women and girls, and they are taking birth control pills to stop their menstrual cycles, which could impact reproductive and mental health in the long term [135].

The impact of CC on public health is further mediated through environmental changes and socio-economic dynamics such as forced displacement due to riverbank erosion and movement towards urban slum settlements [136]. Poor and densely crowded living conditions along with hot and humid weather and frequent water logging creates a favorable condition for water and vector-borne infectious disease breeding and transmission in the urban slum settlements [137,138]. Migration also works as a driver of disease transmission [17]. Women during pregnancy were found to be more vulnerable to *P. falciparum*-infected malaria diseases [139].

CC will have a catastrophic impact on child health and wellbeing—the range, scale, and magnitude is unknown and mostly overlooked [47]. In Bangladesh, children from climate vulnerable areas were found to be 19% more stunted and 23% more underweight than in low-risk areas [140]. Studies from other countries suggest that infant and child mortality becomes high during heatwaves [141]. However, studies in Bangladesh had some opposite results, which imply that some temperature threshold should be considered to understand the local phenomena [142]. Cold weather seemed to be more harmful for children in rural Bangladesh—prenatal deaths increased by 30% for every 1 °C decrease under the 21 °C temperature threshold on cold days [143]; though the situation can become better with CC in Bangladesh. However, hot temperatures could impact children’s health through heatstroke, kidney related diseases, electrolyte imbalance in the body, respiratory diseases including asthma and infectious diseases [144–146].

An increase in precipitation has also been found to be associated with higher childhood fatalities [147]—along with mortality and morbidity from drowning and unintentional injury due to flooding and waterlogging [32]. Drowning has become the major cause of death in the 1–17-year age group in Bangladesh (28.6 per 100,000 child-years) with the highest

incidence among the 1–4 years children (86.3 per 100,000 child-years) [148]. Incidence of diarrhea and pneumonia also increases in rural Bangladesh in the post monsoon [32].

Child mortality is increasing at an alarming rate with worsening drought conditions in different Southern African countries [149]. Children suffer more due to food and water insecurity and malnutrition [150], water and vector-borne infectious diseases [151–153], respiratory diseases [154], and mental health [155] in drought-prone areas; drought puts people into a vicious cycle of poverty, limits their access to health services, and forces them to migrate [47].

Morbidity and mortality risks from water and vector-borne disease will become more severe with climate variability and change in Bangladesh, though with differential severity among different subpopulations, and children are always among the most high-risk population due to their not yet fully developed immune system, lack of protective immunities in the body, and unique pattern of exposure to the toxic environment [156]. Children in Bangladesh are already suffering from common infectious and childhood diseases. Moreover, they are now exposed to emerging diseases, such as hand, foot, and mouth disease (HFMD), commonly known as vesicular stomatitis with exanthema [157]—these all are climate sensitive and impose severe child vulnerability in future outbreaks. Bangladesh has successfully curbed the rate of fatalities in flood and cyclonic events, especially child mortality, through extensive disaster risk reduction programs [158,159]; however, morbidity is still a great concern.

Bangladesh (and small pacific islands) could be the ground zero for CC-induced migration [160]; CC could displace more than 30 million people from coastal districts (seen in [161]). Bangladesh is already sheltering around 3 million “Bihari’s” or stranded Pakistani and 1 million Rohingya communities in Bangladesh that have minimal access to any formal health services [162,163]. Environment and climate-induced migrants subsequently relocate to the urban slums of Dhaka and Chittagong or move to hill tract areas [164], often living in miserable conditions in unhygienic, environmentally polluted and more climate-vulnerable areas without access to adequate health services. Health provision for these climate-induced migrants is almost an absent issue in the local to global context [48,50].

Mental health and wellbeing are also unexplored areas in CC research and are severely neglected issues in Bangladesh [49]. Almost zero attention was given to the mental health illness of disaster survivors in Bangladesh [36]. Slow-onset climate variability and more abrupt and extreme disaster events impact mental health and amplify trauma, distress, anxiety, and psychological damage through multiple and diverse pathways [49] as seen during the COVID-19 pandemic [35]. For Bangladesh, the issue requires unprecedented attention in policy and practice [49].

3.6. Climate Change Preparedness/Health Adaptation in Bangladesh

The primary objective of the scoping review was to explore and synthesize the evidence on how climate change impacts population health in Bangladesh and further understand the health system structure—how it functions, its capacity, and shortfalls against the ongoing and future climate change and disaster landscape. However, there is one thing that hasn’t been explored previously in Bangladesh (and most probably globally): how climate change has been informed and been included in the National Health Policy [15] and its Operational Plans (OPs) [69]. To make the study holistic and cover all aspects of the discourse, we planned to assess how CC has been addressed/responded to/integrated into the health policy and its OPs. However, we were not aware of any climate integrated health policy during the work and thus did not find any specific tool that can assess how the climate change issue is addressed in any health policy or explore the level of integration.

In our search, we looked for the availability of any method or tool that could help in assessing specific issues/topics in any health policy, i.e., CC in this case; however, we did not come across anything similar. Hence, we propose a simple and effective approach—a “5-point scale” based on the five questions to explore CC integration in the health policy Operational Plans (Table 2). The basic idea of such a tool was devised from

the “readiness assessment” approach of the World Bank’s 10 steps to operationalize result-based monitoring and evaluation system [165]. Here, each question has an equal score of 1 and the summed score will define the level of integration (1: mentioned; 2: tried integration; 3: somehow integrated; 4: almost integrated, and 5: fully integrated). Operation Plans, without any mention of climate change, have been marked by “X”. In Bangladesh, it is fairly common to see very well-structured policy and strategic plans but lackluster implementation. Thus, we devised the tool based on the World Bank’s monitoring and evaluation framework so that we could identify different critical issues in relation to planning, budgeting, monitoring and evaluation on the health policy and its OPs. This is a new and unique aspect of the study, and we believe no such effort has been made so far to assess climate change integration in health policy and the respective implementation plans.

Table 2. A “5-point scale” tool to assess climate change integration in 4th HPNSP Operational Plans.

Question	Score	Combined Score	Level of CC Integration	Number of Ops	Name of Ops *
Is climate change mentioned in the OP?	1	1	Mentioned	5	PME, SDAM, PSSM-HS, MNCAH, FP-FSD
If mentioned, is there any specific project and programs on CC included?	1	2	Tried integration	1	NNS
Is there any budget allocated for the project or program?	1	3	Somehow integrated	-	
Is there any indicator to monitor progress?	1	4	Almost integrated	2	HIS and E-Health, CBHC
Is the project or program being integrated with other project or programs in the respective OP?	1	5	Fully integrated	7	SWPMM, PMR, TRD, CDC, TBL, and ASP, NCDC, LHEP
OPs without any mention of climate change	X			14	
Total OPs				29	

* Acronym is used for Operational Plans’ (OPs’) titles. Full title of the OPs was given in Appendix C.

Bangladesh is a very active country in international CC negotiations and this proactivity has also been reflected through domestic actions. It formulated the National Adaptation Programme of Action (NAPA) in 2005, the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2009, and most recently, the National Adaptation Plan of Bangladesh (2030–2050) in 2022—these documents kept public health as a priority area of action [72,74]. This pivotal issue has also been well reflected in the National Health Policy which identified CC as a major public health and developmental challenge and put it as a focus area of intervention primarily as adaptation action [15]. The priority action plans were discussed in detail in the 4th HPNSP OPs—which are 29 in total. We used the “5-point scale” to assess CC integration in the OPs and details of the procedure are provided in Appendix C and the summary results are in Table 2.

Among the 29 Operational Plans, we found that 15 OPs have “mentioned” to “fully integrated” CC considerations; but, the remaining 14 OPs have nothing on CC. From our assessment, here we briefly discuss some of the more important findings. Firstly, CC has been kept as a decisive cross-cutting issue in most of the OPs—which is really a very positive approach. Secondly, almost 25% of the OPs fully integrated CC in their planning and program design within the 5-year implementation period from 2017–2022. Moreover, half of the OPs at least mentioned the CC issue or have a program planned for implementation. However, 14 of the OPs did not include any plan in relation to CC, which seems negative, but has certain co-benefits in relation to climate action (ex: infrastructural development, capacity building, and facility expansion, etc.).

We found that mostly generalized indicators have been used for monitoring and evaluation purposes, rather than climate-specific indicators, number of programs implemented, or amount of money spent in relation to climate responsive health adaptation. We argue that using climate-specific indicators to track achievement and spending will be more appropriate and beneficial [166]. This should ensure transparent reporting and draw climate funding [165]. Additionally, in the absence of climate-specific indicators and budgeting, it is rather impossible to report what percentage of the budget has been allocated for climate-related health adaptation.

As per our assessment, the planned programs and interventions are targeted at the public health sector only. However, as stated before, in the existing pluralistic health system, the private sector plays a significant role, more specifically at the secondary and tertiary levels, but no modality of integration between the two sectors was visible within the OPs. This could become critical, as seen from the recent dengue and COVID-19 epidemics, the public sector is inadequate in serving the population. However, by keeping the major portion of the health system from CC preparedness, training, and capacity building, the success of the overall health system in achieving climate resilience is rather questionable.

There are overlaps regarding interventions among certain OPs and some major ones reported establishing a health surveillance system; however, progress seems quite slow in this regard. Without establishing proper linkage between the public and private sectors, sharing of information and data management would not be possible. Moreover, this is probably truer for generating early warning, which is almost non-existent.

The Bangladesh government has made some phenomenal efforts towards climate action [40,44] and thus, to establish a climate-resilient health system and mainstream climate risks in health system planning and policy intervention, the DGHS under MoHFW of GoB has prepared a draft Bangladesh Health National Adaptation Plan (HNAP) [167]. This document (pending approval) should be implemented parallel to the 4th HPNSP OPs during 2017–2022 and would bring different stakeholders under a common umbrella—policy makers, health professionals and workers, implementers, civil society, and media, partnering with other relevant organizations and institutions. However, we found little prospect in this effort as it remained outside the OPs; further, the document has been prepared following the WHO's "operational framework for building a climate-resilient health system" which is based on six building blocks of the health system [168]; and as we have discussed earlier, Bangladesh's health system cannot be defined by the WHO building block approach and thus, successful implementation of this HNAP remains a concern.

The impact of such health adaptations is yet to reach rural, marginalized, and migrant communities in different CC-vulnerable areas. People are finding it difficult to manage their health with the changing climate and rely on personal experience for treatment. Visiting unqualified/informal health professionals is the primary health coping strategy among the marginalized, rural, and hard-to-reach communities [28]. The situation is even worse for children, more specifically if they are migrants [30].

4. Discussion

We had some interesting and critical findings from the scoping review. Firstly, the common notion that the decision makers and government officials in Bangladesh often mention—"there is not enough evidence available on how climate change will impact public health in Bangladesh" is not totally true at this moment. Rather, we found quite a good amount of evidence on the probable impact of climate change on different subpopulations in Bangladesh. However, there is a substantial gap in including such valuable research findings in policy, planning, program design, and intervention.

Health has been kept under priority action in different CC policies in Bangladesh. Subsequently, the National Health Policy and its OPs put CC as a major cross-cutting issue—which is a significant step towards building a climate resilient health system. We see that almost half of the 29 OPs have some level of CC integration, while close to 25% of the OPs fully integrated CC in their planning and action. However, the quality of the

proposed actions and their outcome are yet to be evaluated, as some previous findings are rather contradictory [43]. The other OPs also have significant CC co-benefit, which is quite positive.

Bangladesh further strengthened its effort to achieve climate resiliency in the health sector by developing the Health National Adaptation Plan (HNAP), which could become a very effective policy approach to integrate CC in short, medium, and long-term health sector planning and intervention [167]. The important policy document formulated 10 components based on the WHO building blocks of the health system, but the success of such an approach against the existing pluralistic health system is yet to be examined. The document also listed component-wise challenges and plans for overcoming them, which could prove to be immensely beneficial for other countries, facing climatic adversity of different scales and magnitude.

In recent years, the MoHFW had some remarkable achievements in establishing health provisioning through its sector-wide approach (presently being the 4th HPNSP) in many rural and hard-to-reach areas; but its stewardship is greatly suppressed in urban areas due to institutional incapacities and the legal framework, resulting into poor coordination and mismanagement [41]. In addition, as we discussed, the policy and planning only considered the public sector, which is more like “trying to win a race by tying two legs intentionally”. The contribution of the private and informal sector must be acknowledged, modality of cooperation must be established, and proper information sharing, surveillance, and early warning systems must be initiated [40,42,44]. Special health interventions must be designed to target CC-vulnerable displaced and migrant communities [30]. Mainstreaming traditional medicines could be initiated as health adaptation as they are more affordable and accessible to rural communities and can improve the local health coping mechanisms [29]. Bangladesh has been gifted by the praiseworthy leadership of Hon’ble Prime Minister Sheikh Hasina, which is readily visible in the success of the health sector by keeping the death toll in the COVID-19 pandemic to a minimum with effective coordination at a national level and strong international negotiation for vaccine acquisition. Bangladesh could use this example as a founding stone for CC integration in the health sector and establish a climate-resilient health system.

This study is probably the first of this kind, that has tried to explore the health system readiness against ongoing and future climatic challenges in a country and has also created a tool to assess the level of climate change integration or consideration in health policy and health sector implementation plans, which is very relevant in today’s world if we investigate the list of countries most vulnerable to climate change [13]. The list contains countries from least developed to developing and developed countries and thus have differential coping and adaptation capacities to climate change. However, as we stated, we did not come across any document that explored climate change preparedness in the health system. Therefore, this study can work as a guiding beacon to enlist such studies because today or tomorrow, every nation must assess its health system readiness against such climatic adversities.

The COVID-19 pandemic has shown us the actual status of the health system and people should take notice because in a changing world, such events will become more frequent. The lesson learned could be started from anywhere. Bangladesh being a champion in disaster risk reduction, could easily take the lead. As Bangladesh and small island nations are particularly vulnerable to SLR-induced migration, the health system preparedness to deal with climate migrants would be relevant to many other countries as they will face such challenges, and maybe quicker than anticipated.

The uniqueness of the study lies in its developed “5-point scale” to assess CC integration in health policy operational plans. Countries can work with this tool or modify it as per local contexts and use it as an instrument to explore health system preparedness against CC. We also listed key suggestions concerning health system adaptation that should prove to be critically important to any countries facing the threat of CC. The study used Bangladesh as its case, but the discussions presented here are relevant to every nation in

this world. We believe, the study will immensely benefit countries and communities in health adaptations and the establishment of a climate-resilient health system.

Within the limited scope of this scoping review, we tried to draw a comprehensive picture of the existing health system; in contrast to previous studies—we not only focused on gaps and challenges, but rather concentrated attention on the strength, capacity, and readiness of the system in integrating CC. We explored how CC has been included in NHP and HNAP and devised a simple tool to assess the level of CC integration in the 4th HPNSP OPs and we conclude that Bangladesh has made some substantial progress at least in policy and planning. However, the full extent of the benefit at the outcome level is yet to be evaluated.

As for limitations of the work, the whole study has been carried out within the pandemic by a single researcher. Thus, the assessment, exploration, and views presented in the article are from the author only. For such an immense task, a parallel evaluation of the scooped article might have enhanced the overall quality of the discussion. Moreover, due to the time constraints, we could not explore more assessment tools for health policy evaluation. We assumed that sharing the study findings with appropriate health policy makers and stakeholders should enrich the overall quality of the work. However, such an opportunity could not be availed due to the prevailing pandemic situation. No ethical approval was required as the information search was carried out in publicly accessible electronic databases.

5. Conclusions

Life in the Anthropocene will be difficult, specifically in countries such as Bangladesh, that will further endure the severe burden of CC and catastrophic negative impacts on public health. To fight climatic adversity and manage population health, the country will have to focus substantial attention on the “climate–health–wellbeing” nexus, recognize the gaps, barriers, and challenges within the system, connect health, environment, and CC within a common framework, and incorporate CC preparedness in its health system.

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Institutional Review Board Statement: No ethical approval was required due to the secondary nature of the work.

Informed Consent Statement: Not applicable.

Data Availability Statement: The details database search query is presented in Appendix A. There is no additional data to share externally.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Key words and ‘Mesh’ terms for database search.

“Health Adaptation”	“Climate Change and Health”	“Health System in Bangladesh”
“Health adaptation” OR “Policies and practice” OR “Adaptation planning” OR “Policy” OR “Guideline” OR “National Health Policy” OR “Health Policy” OR “Operational Plans” OR “Action plan” OR “Public Policy +” OR “Strategy” OR “Government policy” OR “Strategic plan” OR “Action” OR “Policy reformation” OR “Health policy evaluation” OR “Health sector adaptation” OR “Health sector resilience” OR “Health sector preparedness” OR “health system adaptation” OR “action plan”	“Climate change and health” OR “Global Warming and health” OR “Sea Level Rise and health” OR “Climate change and Adolescent Health” OR “Climate change and Child Health” OR “Climate change and Global Health” OR “Climate change and Infant Health” OR “Climate change and Mental Health” OR “Climate change and Occupational Health” OR “Climate change and One Health” OR “Climate change and Population Health” OR “Climate change and Rural Health” OR “Climate change and Suburban Health” OR “Climate change and Urban Health” OR “Climate change and coastal health” OR “Climate change and Public Health” OR “Climate change and Reproductive Health” OR “Climate change and Social Determinants of Health” OR “Climate change and Men’s health” OR “Climate change and Women’s Health” OR “Climate change and Maternal Health” OR “Climate change and mental health”	“Bangladesh health sector” OR “Health in Bangladesh” OR “Bangladesh health sector” OR “Health system in Bangladesh” OR “Health policy Bangladesh” OR “National Health policy Bangladesh” OR “Climate Change Strategy and Action Plan Bangladesh” OR “National Adaptation Plan for Action Bangladesh” OR “Health, Population and Nutrition Sector Programme Bangladesh” OR “4th Health, Population and Nutrition Sector Programme” OR “4th HPNSP”
1,926,890	9003	3693
Initial hits		44 results
Final hits (after applying other filters)		36 results

Appendix B

Table A2. Excluded articles from literature review.

S/n	Author—Article Title—Article Reference	Reason for Exclusion
1	Ahasan N. Climate change: Impact on health. Journal of Medicine. 2010;11(1):1–2.	Editorial
2	Alam N, Chowdhury HR, Ahmed A, Rahman M, Streatfield PK. Distribution of cause of death in rural Bangladesh during 2003–2010: evidence from two rural areas within Matlab Health and Demographic Surveillance site. Glob Health Action. 2014;7:25510.	Not useful to research topic
3	Alam N, Chowdhury HR, Das SC, Ashraf A, Streatfield PK. Causes of death in two rural demographic surveillance sites in Bangladesh, 2004–2010: automated coding of verbal autopsies using InterVA-4. Glob Health Action. 2014;7:25511.	Not useful to research topic
4	Alam N, Lindeboom W, Begum D, Streatfield PK. The association of weather and mortality in Bangladesh from 1983–2009. Glob Health Action. 2012;5:53–60.	More updated article available in the same topic
5	Bodrud-Doza M, Shammi M, Bahlman L, Islam A, Rahman MM. Psychosocial and Socio-Economic Crisis in Bangladesh Due to COVID-19 Pandemic: A Perception-Based Assessment. Front Public Health. 2020;8:341.	Article came from same/same type study—more relevant one included
6	Chatterjee S. Rights, risks and resilience: The 3Rs approach to child-centred climate change adaptation in Asian cities. Responding to Climate Change in Asian Cities: Governance for a More Resilient Urban Future 2016. p. 33–55.	Not useful to research topic
7	Chowdhury MA, Hasan MK, Hasan MR, Younos TB. Climate change impacts and adaptations on health of Internally Displaced People (IDP): An exploratory study on coastal areas of Bangladesh. Heliyon. 2020;6(9).	Not useful to research topic
8	Das S, Kumar B, Kawsar LA. Disaggregated level child morbidity in Bangladesh: An application of small area estimation method. PLoS ONE. 2020;15(5).	Article came from same/same type study—more relevant one included
9	Haque MA, Yamamoto SS, Malik AA, Sauerborn R. Households' perception of climate change and human health risks: a community perspective. Environ Health. 2012;11:1.	Article came from same/same type study—more relevant one included
10	Haque U, Hashizume M, Kolivras KN, Overgaard HJ, Das B, Yamamoto T. Reduced death rates from cyclones in Bangladesh: what more needs to be done? Bull World Health Organ. 2012;90(2):150–6.	Not useful to research topic
11	Huda MN. Understanding indigenous people's perception on climate change and climatic hazards: a case study of Chakma indigenous communities in Rangamati Sadar Upazila of Rangamati District, Bangladesh. Natural Hazards. 2013;65(3):2147–59.	Not useful to research topic
12	Kabir A, Islam MZ, Ahmed A, Rahman MS, Rahman S. Health and drinking water supply vulnerabilities to climate variability in coastal and drought-prone areas of Bangladesh. International Journal of Climate Change: Impacts and Responses. 2019;11(2):41–56.	Not accessible
13	Kabir MI, Rahman MB, Smith W, Lusha MA, Milton AH. Climate change and health in Bangladesh: a baseline cross-sectional survey. Glob Health Action. 2016;9:29609.	Article came from same/same type study—more relevant one included
14	Khan AE, Xun WW, Ahsan H, Vineis P. Climate Change, Sea-Level Rise, & Health Impacts in Bangladesh. Environment: science and policy for sustainable development. 2011;53(5):18–33.	More updated article available in the same topic
15	Lindeboom W, Alam N, Begum D, Streatfield PK. The association of meteorological factors and mortality in rural Bangladesh, 1983–2009. Glob Health Action. 2012;5:61–73.	Not useful to research topic
16	Mobarak Hossain Khan M, KrÄMer A, Khandoker A, PrÜFer-KrÄMer L, Islam A. Trends in sociodemographic and health-related indicators in Bangladesh, 1993–2007: will inequities persist? Bulletin of the World Health Organization. 2011;89(8):583–92.	Not useful to research topic

Table A2. Cont.

S/n	Author—Article Title—Article Reference	Reason for Exclusion
17	Nayna Schwerdtle P, Stockemer J, Bowen KJ, Sauerborn R, McMichael C, Danquah I. A Meta-Synthesis of Policy Recommendations Regarding Human Mobility in the Context of Climate Change. International journal of environmental research and public health. 2020;17(24):9342.	Article came from same/same type study—more relevant one included
18	Rahman MM, Ahmad S. Health, livelihood and well-being in the coastal delta of Bangladesh. Ecosystem Services for Well-Being in Deltas: Integrated Assessment for Policy Analysis 2018. p. 131–45.	Not useful to research topic
19	Rasul CH, Mostafa KG, Baruri NN, Ballav SK, Roy PK. Comparative study of climate related target diseases in the coastal and plain area of Southern Bangladesh. Malaysian Journal of Public Health Medicine. 2015;15(2):24–31.	Not useful to research topic
20	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. Environ Health Perspect. 2017;125(5):057007.	Not useful to research topic
21	Schwerdtle PN, Stockemer J, Bowen KJ, Sauerborn R, McMichael C, Danquah I. A meta-synthesis of policy recommendations regarding human mobility in the context of climate change. International Journal of Environmental Research and Public Health. 2020;17(24):1–30.	Article came from same/same type study—more relevant one included
22	Shahid S. Probable Impacts of Climate Change on Public Health in Bangladesh. Asia-Pacific journal of public health. 2010;22(3):310–9.	More updated article available in the same topic

Appendix C

Table A3. Assessment of climate change integration status in 4th HPNSP Operational Plans.

s/n	Operational Plans (OPs)	Is Climate Change Mentioned in the OP?	If Mentioned, Is There Any Specific Project and Programs on CC Included?	Is There Any Budget Allocated for the Project or Program?	Is There Any Indicator to Monitor Progress?	Is the Project or Program Being Integrated with Other Project or Programs in the Respective OP?	Score/Level of Integration
1	Sector-wide Program Management and Monitoring (SWPMM)	✓	✓	✓	✓	✓	5/Fully integrated
2	Planning, Monitoring and Research (PMR)	✓	✓	✓	✓	✓	5/Fully integrated
3	Planning, Monitoring and Evaluation (PME)	✓					1/Mentioned
4	Health Economics and Financing (HEF)	X					
5	Strengthening Drug Administration and Management (SDAM)	✓					1/Mentioned
6	Health Information System and E-Health (HIS and E-Health)	✓	✓	✓	✓		4/ Almost integrated
7	Management Information System (MIS)	X					
8	Procurement, Storage and Supplies Management-HS (PSSM-HS)	✓					1/Mentioned
9	Procurement, Storage and Supplies Management FP (PSSM-FP)	X					
10	Human Resources Development (HRD)	X					
11	Medical Education and Health Manpower Development (ME and HMD)	X					
12	Nursing and Midwifery Education Services (NMES)	X					
13	Training, Research, and Development (TRD)	✓	✓	✓	✓	✓	5/Fully integrated
14	Physical Facilities Development (PFD)	X					
15	Improved Financial Management (IFM)	X					
16	Maternal, Neonatal, Child and Adolescent Health (MNCAH)	✓					1/Mentioned
17	Maternal, Child, Reproductive and Adolescent Health (MCRAH)	X					
18	National Nutrition Services (NNS)	✓	✓				2/Tried integration
19	Communicable Disease Control (CDC)	✓	✓	✓	✓	✓	5/Fully integrated
20	Tuberculosis-Leprosy and AIDS STD Program (TBL and ASP)	✓	✓	✓	✓	✓	5/Fully integrated
21	Non-communicable Disease Control (NCDC)	✓	✓	✓	✓	✓	5/Fully integrated
22	National Eye Care (NEC)	X					
23	Community Based Healthcare (CBHC)	✓	✓	✓	✓		4/ Almost integrated
24	Hospital Services Management (HSM)	X					

Table A3. Cont.

s/n	Operational Plans (OPs)	Is Climate Change Mentioned in the OP?	If Mentioned, Is There Any Specific Project and Programs on CC Included?	Is There Any Budget Allocated for the Project or Program?	Is There Any Indicator to Monitor Progress?	Is the Project or Program Being Integrated with Other Project or Programs in the Respective OP?	Score/Level of Integration
25	Clinical Contraception Services Delivery Program (CCSDP)	X					1/Mentioned
26	Family Planning Field Services Delivery (FP-FSD) Lifestyle and Health	✓					
27	Education and Promotion (LHEP)	✓	✓	✓	✓	✓	5/Fully integrated
28	Information, Education and Communication (IEC)	X					
29	Alternate Medical Care (AMC)	X					

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