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How is Bangladesh Growing More Susceptible to Infectious Disease Epidemics as a Result of Climate Change? A Systematic Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Systematic Review Article

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ABSTRACT

Bangladesh is facing unpredictable weather patterns, as well as a consistent rise in temperature and precipitation. Climate change has had a negative impact on physical and mental health, leading to an increase mostly in the prevalence and variation of infectious diseases, as well as psychological issues such as depression and anxiety disorders. Given the country's inherent

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sensitivity to climatic influences, the climate-health nexus is a relatively unexplored subject of research. The purpose of this article is to investigate the severity of climate change in Bangladesh and how it impacts the health of the public. Morbidity and mortality due to heat stress, cyclones, floods, droughts, and other weather extremes at various spatiotemporal scales have been observed as direct effects of climate change in Bangladesh. The indirect effects involve more complicated paths, such as affecting food and water security due to salinity intrusion and the development of infectious diseases because of shifts in vector and pathogen ecology. To mitigate the effects of climate change on various infectious diseases, healthcare and response systems must be strengthened. By implementing proactive adaptation methods, we may significantly and actively contribute to preventing and regulating the negative consequences of climate change on human health. There is little evidence to make sound health policy decisions in the context of climate change, and there is a lack of multidisciplinary research activities. Despite these constraints, gathering and reporting scientific information is essential for developing a resilient health system in climate-vulnerable countries like Bangladesh and other low-income regions.

Keywords: Climate change; emerging infectious disease; human health; Bangladesh.

1. INTRODUCTION

Climate change has been one of the most important challenges and one of the most serious threats to human health and well-being [1]. The Lancet Commission and the World Health Organization (WHO) have pronounced climate change to be "The greatest global health danger of the twenty-first century" [2-4]. The study of the relationship between the environment and health has acquired a lot of interest since the Intergovernmental Panel on Climate Change (IPCC) published its first report in 1990 [5]. Since then, numerous evidence-based findings have emerged showing how climate change has affected people's health [6-8]. The health implications of rising temperatures, numerous infectious diseases, and modifications in rainfall patterns are some examples of these effects [9-10]. On a global scale, human-induced climate change endangers ecosystems and human health [11].

Climate change can affect health in a variety of ways, either directly or indirectly [12-15], particularly when social and environmental elements are involved. Only a few of the direct consequences of climate change include increased biological impacts of heat stress, extreme weather events such as floods and drought, and an increase in the frequency and intensity of cyclones (during particular seasons) [16-19]. Changes in natural processes and services, the evolution of disease vectors, air pollution, food and water scarcity, undernutrition, eviction, and mental illness, on the other hand, may all represent indirect hazards to public health. Climate change can have an impact on human health [2,20-22], particularly when it comes to infectious diseases [9,23]. Climate or weather changes influence the basic spatial and seasonal constraints of infectious disease transmission involving three critical components: an agent (or pathogen), a host (or vector), and the transmission environment [24]. Appropriate climate and weather conditions are required for disease pathogens, vectors, and hosts to survive, reproduce, spread, and transmit [25-26,20]. Many investigations have reported on the temporal and spatial influence of climate variability on the spread of infectious illnesses such as vector-borne, rodent-borne, food-borne, and water-borne diseases [8,9,27]. Infectious diseases are mostly affected by climate change through the expansion of insect vectors and contaminated water [1, 28,29]. Infectious disease distribution and prevalence are expected to grow globally due to climate change, which raises the possibility of an impending social crisis [30]. A number of serious infectious disease outbreaks have occurred in the twenty-first century, not the least of which is the COVID-19 pandemic, which has wreaked havoc on people's lives and way of life all across the world [31].

Shifts in temperatures and weather patterns over a long period of time are referred to as climate changes. These changes might be biological, but human activity has been the main driver of climate change since the 1800s. This is mainly due to the burning of fossil fuels (including coal, oil, and gas), which produces heat-trapping gases [32].

There are considerable gaps in understanding the impact of climate change on health,

livelihood, and well-being in lower middle-income nations like Bangladesh, which is one of the world's most climate-sensitive countries. While Bangladesh has some isolated evidence linking climate change to greater rates of death and morbidity from certain illnesses, there is no thorough evaluation of the existing data and no agreement on the effects of climate change and emerging infectious diseases on human health. There are gray literature outputs, but they cannot be published in peer-reviewed journals due to a lack of local experts. Bangladesh, a country in South Asia with a population of around 160 million people, is one of the countries with the densest populations in the world [33]. The majority of the country is low-lying, and floodplains cover 80% of it [34,35,11]. The monsoon season plays a crucial role in determining Bangladesh's hot, humid weather [36]. Pre-monsoon (March to May), monsoon (June to early October), post-monsoon (December to February), and late-monsoon (October to November) are the four distinct seasons [11]. Because of its geographic location, Bangladesh is one of the nations that is most vulnerable to disasters [37]. The weather has a significant impact on health. Climate restricts the variety of infectious diseases, whereas weather affects the timing and intensity of outbreaks [38].

Infectious illness prevalence, socioeconomic factors, and climate change all have a long-term co-integrating relationship [39]. In Nepal, the prevalence of infectious diseases is significantly impacted by climate change [40-41]. Compared to industrialized regions, Bangladesh and other developing nations have been disproportionately impacted by climate change [42]. Infectious diseases are spreading, and together with changes in plant ecosystems and the melting of alpine glaciers, the ranges of infectious disorders and their vectors are changing northward [20,43] Extreme weather conditions can also lead to "clusters" of water-, rodent-, and insect-borne illnesses, food, water, and vector-borne infections [38,44,20]. Bangladesh has much fewer greenhouse gas emissions than many other industrialized countries [45-46], but the country faces a grave threat from climate change to its people's health [38]. Following the natural disaster, the incidence of diarrhea, skin conditions, dengue fever, hepatitis (jaundice), and other infectious disorders has increased [47,48] and The majority of health professionals, service providers, and residents in coastal areas are more knowledgeable about the effects of climate change on health [49], but they are less knowledgeable about the precautions that should be taken [48].

The priority should be on minimizing the effects of climate change, particularly any potential repercussions on the prevalence of infectious diseases globally [50]. Even though the world is significantly warmer than it was a century ago, there is little evidence that infectious diseases have already become more common because of climate change [51]. More recent models indicate range shifts in disease distributions, with no net expansion in the area, in contrast to earlier predictions that predicted the global range of infectious diseases will drastically increase in the future.

In Bangladesh, the majority of climate research is concentrated on agriculture, hydrological, and other environmental issues, highlighting the glaring dearth of health specialists in the field. Furthermore, a detailed study of the incomplete data that is now accessible has not yet been carried out. According to the author's best judgment, there is no concrete proof that the impact of climate change on emerging infectious diseases might be evident in Bangladesh. Making informed judgments on health policy in relation to climate change is difficult due to a lack of transdisciplinary research and evidence. By compiling the data that is easily available and under our control, the current review aims to close the information gap. In this review, we investigate the evidence for changes in infectious disease incidence, distribution, localized outbreaks, and the potential for tropical vector species to establish in Bangladesh because of climatic changes. We anticipate that this analysis will contribute to the existing discussion involving the debate about climate change and serve as a resource for stakeholders from a variety of disciplinary backgrounds.

2. METHODOLOGY

Through inquiry, it has been revealed how much Bangladesh's climate is changing and how it is affecting people's health [38,20]. Infectious disease is influenced by a variety of variables, some of which may even be more significant than climate-related factors [30]. So, the relationship between climate change and infectious diseases in Bangladesh requires rigorous examination and investigation.

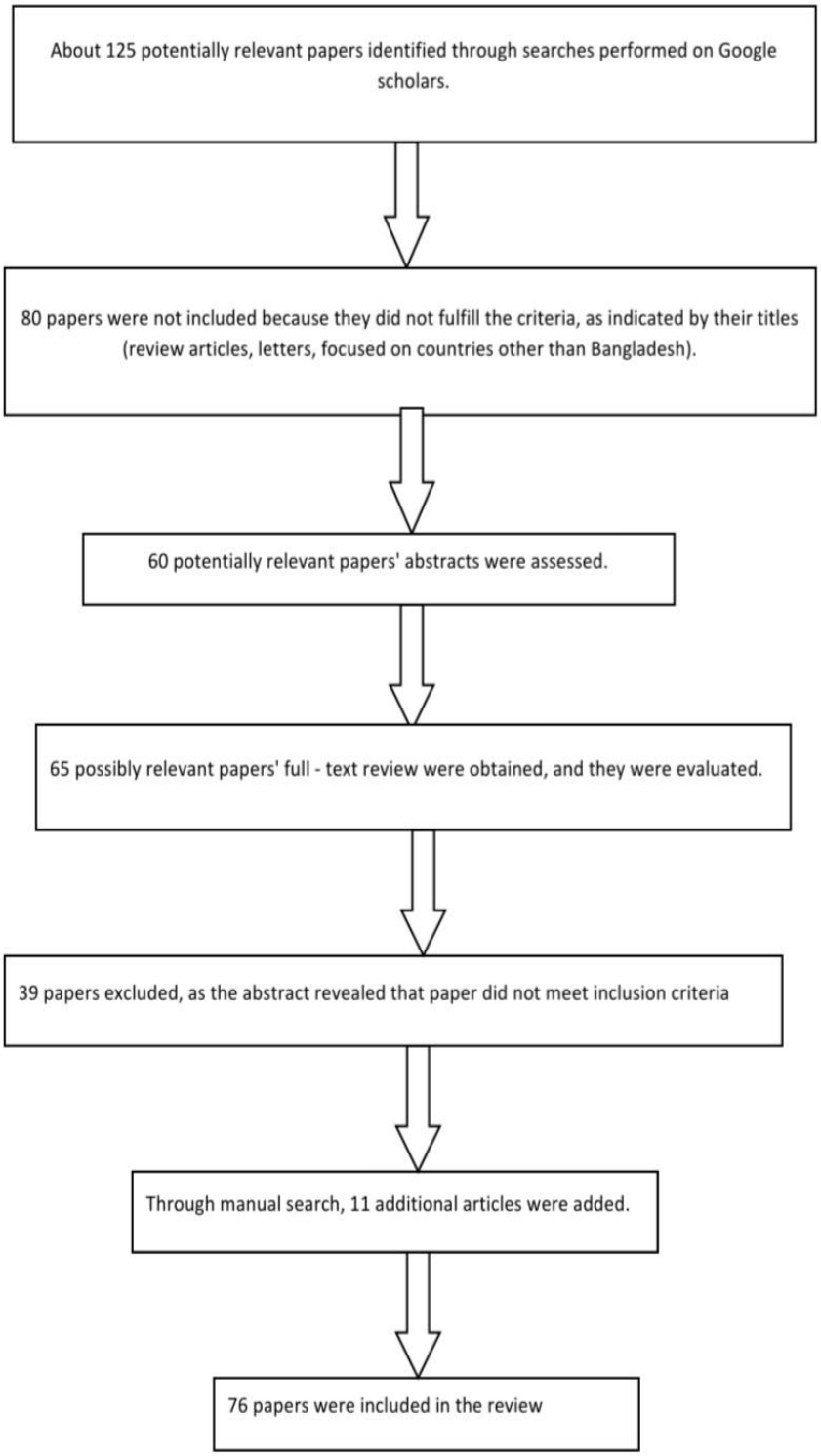

Fig. 1. Flow chart of combining papers by searching for our review paper

This review evaluated the effects of climate change on Bangladeshi citizens' health. Multiple databases were picked to discover relevant articles. We got information about climate change, infectious diseases, and their effects on health from those periodicals. The potential

effects of the connection between human infectious diseases and climate change are discussed here. In our research, we also explore how climate change is altering the types of infectious diseases and their vectors, greenhouse gas emissions, how much Bangladesh's climate is changing, and how it is affecting the health of its citizens. Finally, we combined all types of information about the effects of climate change on human health (Fig. 1). But in this topic, we've tried to give some original material on the potential effects of extreme weather on human's infectious diseases of Bangladesh. In the future, we'll work on more connected projects that are associated with infectious diseases and adverse climate changes. The number of papers published each year that match their search criteria is shown by the blue bars. The total number of papers is displayed on an orange line (Fig. 2).

2.1 Vector Borne Disease

Climate change causes extreme weather patterns, which also affect vector-borne diseases [52,53]. In order to determine parasite activity levels and illness risk, it is critical to understand the relationship between climatic variables and vector-borne diseases [54]. The likelihood of dengue fever, Chikungunya, and Zika virus will increase as global temperatures and weather patterns change due to climate change [55,56]. Warmer temperatures have the potential to broaden the geographic range of habitats where vectors, such as mosquitos and ticks, can live and lay eggs [57].

2.2 Mosquito Borne Disease

Climate is one of the factors influencing the growth of malaria cases. Climate change is responsible for 2% of all malaria cases worldwide [50].

2.3 Arboviral Diseases

Aedes aegypti, the leading mosquito vector of arboviral diseases such as dengue, chikungunya, yellow fever, and Zika, threatens about half of the world's population. The rise in global temperatures is partially responsible for this increase [58]. As temperatures approach the predicted thermal optimum, Zika may spread further north with longer seasons [57].

2.4 Tick-Borne Diseases

The spread of Lyme disease, Rocky Mountain spotted fever, and leishmaniasis is aided by high temperatures, the creation of tick populations, an increase in their range, and recent geographic expansion [57].

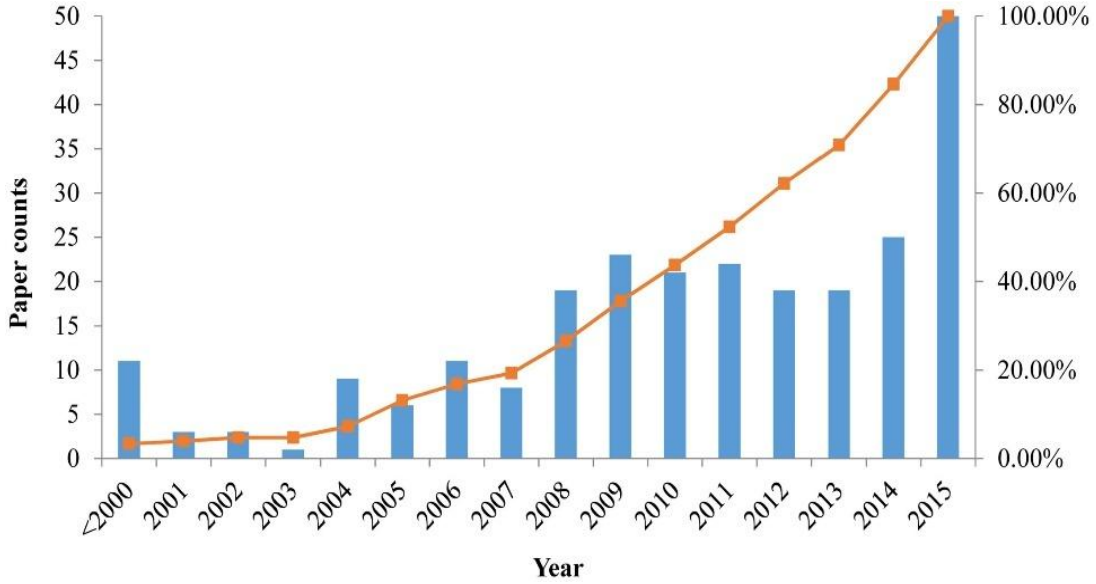

Fig. 2. Growing awareness of the links between climate change and health [24]

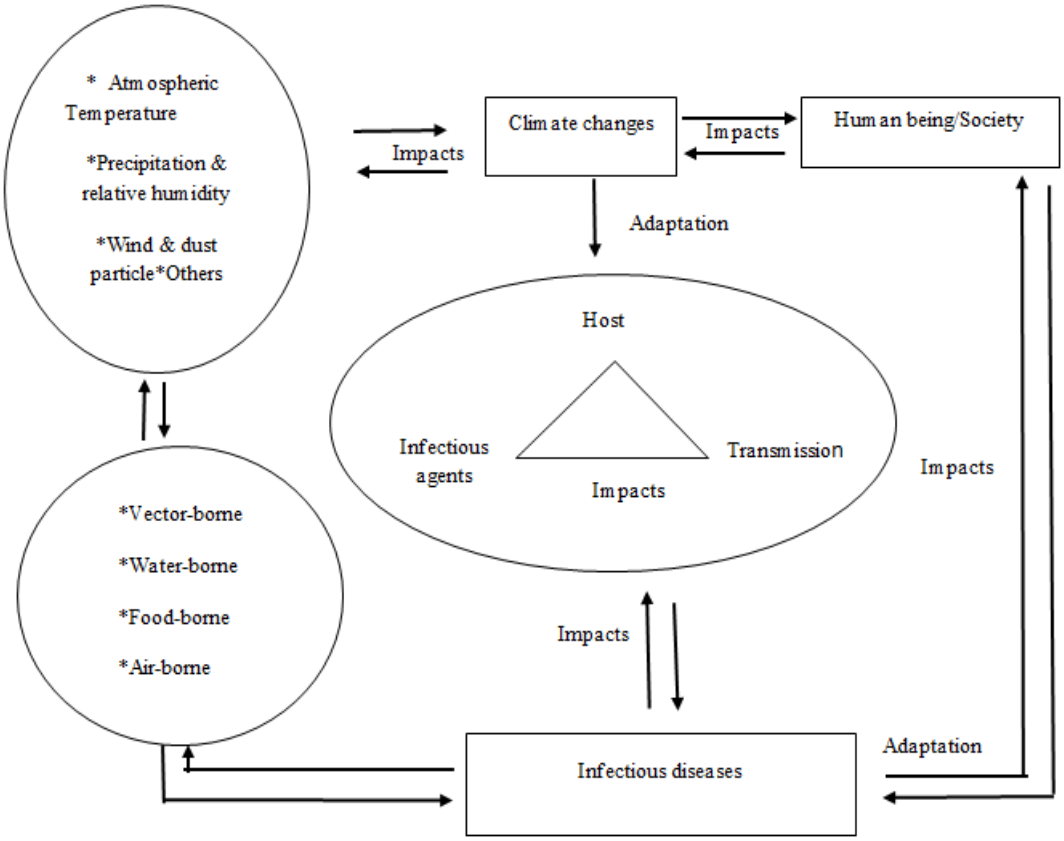

Fig. 3. Climate change, human infectious diseases, and human society [1]

2.5 Food-Borne Diseases

The number of viruses that propagate depends significantly on the environment. The geographic distribution, variety, levels, and seasonality of the pathogen in the natural and agricultural environment may therefore change because of changing environmental factors, such as changes in precipitation temperature [59,60]. In the end, this affects the number of pathogens in food, and climate change will bring about a rise in temperature and precipitation, both of which affect the spread of infectious diseases through contaminated food and water [61]. Salmonella is sensitive to the climate and thrives in a small temperature range with pronounced seasonality [62]. However, it is anticipated that the threat to food safety posed by both recent and emerging food-borne illnesses will increase as ambient temperature rises and severe weather events become more frequent [63].

2.6 Water-Borne Diseases

Drinking contaminated water or coming into contact with it can spread waterborne infections [64]. Water shortages and drought can also give rise to cascading risks and cause diarrheal diseases, although this association has been documented inconsistently [57, 58]. Water-borne outbreaks can occur because of climate variability and change followed by secondary events that are causally connected [65, 57]. Vibrio cholera has been linked to several climatic factors, poor WASH conditions, and areas where cholera has already been introduced to the populational [25]. High rainfall might increase the chance that treated or untreated water will get contaminated by wastewater (person-to-environment transmission) [57]. Leptospirosis outbreaks can be brought on by contaminated floodwater or drinking water, highlighting the interplay between climate risk, societal vulnerability, and population exposure in the development of cascade risk pathways for leptospirosis [41]. Respiratory infections frequently have high seasonality, with a wintertime peak in frequency. This is partly due to improved pathogen survival, indoor congestion, and greater host vulnerability [66]. For instance, temperature and humidity have an impact on influenza incidence in temperate regions around the world [67].

2.7 Rodent-Borne Diseases

Some human diseases are carried by rodents [68,69]. Weather has an impact on rodent numbers [70]. Flooding is linked to some rodent-borne diseases, such as plague, Hantavirus, and Lyme disease, while the others are linked to rats and ticks [61]. Rodent population density and weather-sensitive behavior frequently have an impact on the frequency of transmission of these diseases [71,47].

2.8 Plague

The Yersinia pestis bacteria, which causes plague, is spread by fleas that feed on black rats (Rattus rattus) [72, 73]

2.9 Hantavirus Infections

Weather can affect hantavirus infection; for example, increased grass seed production following a period of heavy precipitation has been linked to an increase in the number of deer mice, which resulted in an outbreak in the Four Corners region of the United States (New Mexico) [27].

3. CONCLUSION AND POLICY IMPLICATIONS

Climate change may have opposing effects on pathogen, vector, and ultimately disease outcomes at distinct regional and temporal dimensions [74-75]. The complexity of how various changes interact and affect any one of the three characteristics of human infectious illnesses may be a factor in our inability to fully comprehend how climate change will affect human health as a whole [76]. New challenges to human infectious disease health brought on by climate change will limit some diseases' ability to spread while promoting others [77, 30, 78]. One of the best strategies for human society is to lessen vulnerability by implementing adaptation measures [79]. Advancements in science and society are required in a number of areas to choose the optimum adaptation approach [80]. People are not merely passive beneficiaries of climate change's negative health effects [1]. By taking proactive adaptation strategies, we may significantly and actively contribute to reducing and controlling the harmful effects of climate change on human health [81]. It is critical to first predict how localized climate change may affect the spread of infectious illnesses [82]. The country will be better able to track the progression of diseases that are influenced by the climate and predict disease outbreaks [1, 83]. Second, even with the same level of climate change, some locations and population groups are more vulnerable to the increasing risks because they are underequipped and unable to cope with the demands and challenges [11]. To reduce their susceptibility to health threats brought on by climate change, industrialized countries and competent societies should cooperate with developing countries and less capable societies [84]. Area-specific treatments guided by local-level planning of the low-income vulnerable communities are required to address the prevention and control of climate-sensitive diseases [1,85]. Improve health systems to avoid and limit the spread of infectious diseases as well as other recently discovered or rediscovered climate-sensitive diseases [1,83]. Third, by taking the appropriate adaptation strategies, human vulnerability to the evolving risks for infectious diseases may be modified [86].

3.1 Next Steps or Challenges

Early warning systems built on these estimates have been successful in assisting societies in taking preventative measures to limit or avert potential health repercussions [87]. Increase response to mental health issues through raising awareness, enhancing evaluation processes, and supporting methods for addressing deficiencies, such as self-help groups [1,83]. To lower Out-Of-Pocket expense (OOP) payments for climate victims through alternative healthcare finance, government actions, strong public-private advocacy, and international partnerships are required [88]. In the end, climate change affects health, so community-based public healthcare facilities should be ready to be used to their fullest capacity [89]. Studies including child-centered and school-based interventions could be investigated to lower seasonal childhood pneumonia, malnutrition, and diarrhea [90].

Based on the results of this survey, future cohort studies could assist decision-makers and public health experts in lowering the health costs that climate change is imposing on Bangladesh and other developing countries [91]. By implementing the measures to control diarrheal illnesses, a consistent supply of clean water, and sanitary facilities, Bangladesh, particularly in vulnerable places, will be able to control other water-borne illnesses including typhoid and hepatitis A [38]. Reforestation will reduce the consequences of

climate change by halting soil erosion and improving air quality [92]. Health must come first in any adaptation plans for climate change. Significant and ongoing study is also necessary to understand how climate change and health are related. If quick action is not taken to reduce and adapt to climate change, Bangladesh will pay a heavy price in terms of productivity and human life [38].

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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