

# A Mosquito's Tale: Navigating Dengue Challenges in Bangladesh

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### ABSTRACT

*Dengue is a significant public health concern in numerous tropical and subtropical nations like Bangladesh, especially in industrial and semi-urban regions, which have witnessed the majority of outbreaks. An estimated 50 million dengue infections occur worldwide annually and it has been included among the top ten global health hazards by the World Health Organization. Humans are among the only known hosts for the dengue virus, which is spread by the Aedes mosquito. In Bangladesh, the prevalence of dengue has experienced a substantial rise over the past 35 years, with growing urbanization, modernization, and global warming being widely regarded as the primary drivers. Factors like rapid urbanization, unchecked population growth, failing waste management systems, and absence of effective vector control contributed to the rise and spread of dengue infection in the country. This review paper aims to thoroughly examine the dynamics of dengue infection, with a focus on the interrelated impacts of climate, urbanization, and public health preparedness in Bangladesh. The approach entails analyzing past viewpoints, changes in population, and factors that influence society, while also evaluating government policies, ethical concerns, and initiatives sponsored by the community. The review will try to discover effective techniques for dengue prevention and control by examining successful community development initiatives and behaviour change models.*

**Keywords:** Dengue, public health, prevention and control, climate change, urbanization, Bangladesh

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### INTRODUCTION

Dengue is a significant public health concern in numerous tropical and subtropical nations, especially in industrial and semi-urban regions, which have witnessed the majority of outbreaks.<sup>1</sup> An estimated 50 million dengue infections occur worldwide annually and it is included among the top 10 global health hazards by the World Health Organization (WHO).<sup>2</sup> Bangladesh is located in the tropical and subtropical regions, similar to other Southeast Asian countries. Consequently, it has become an ideal breeding ground for the dengue vector and the subsequent rise in its spread.<sup>3</sup> Humans are among

the only known hosts for the dengue virus, which is spread by the Aedes mosquito.<sup>2</sup> The prevalence of dengue has experienced a substantial rise over the past 35 years, with growing urbanization, modernization, and global warming being widely regarded as the primary drivers.<sup>4</sup> A number of factors, including rapid urbanization, unchecked population growth, failing waste management systems, and an absence of effective vector control, contribute to the occurrence and spread of dengue.<sup>5</sup> However, this review paper aims to thoroughly examine the dynamics of dengue infection, with a focus on the interrelated impacts of climate, urbanization, and

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public health focusing on Bangladesh. The approach entails analyzing past viewpoints, changes in population, and factors that influence society, while also evaluating government policies, ethical concerns, and initiatives sponsored by the community. The review will try to discover effective techniques for dengue prevention and add to the debate on public health improvement by examining successful community development initiatives and behavior change models.

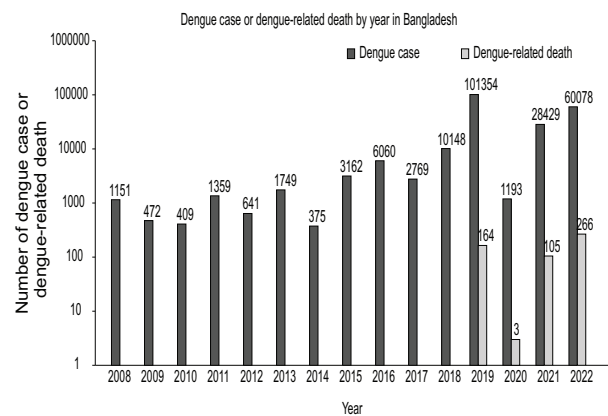
### HISTORICAL PERSPECTIVE OF DENGUE IN BANGLADESH

In the 1780s, there was a dengue outbreak that was recorded in North America, Africa, and Asia nearly at the same time.<sup>6</sup> Dengue fever, formerly known as 'Dacca fever',<sup>7</sup> was initially documented in the 1960s in Bangladesh (formerly East Pakistan). Until 1965, there were only a few isolated reports of dengue cases in Bangladesh, leading people to believe that the country was free from the disease.<sup>8</sup> However, it was not until the 21st century that the disease became epidemic and eventually endemic due to metropolitan cycles and the establishment of the "domesticated" insect vector *Aedes aegypti*.<sup>9,10</sup>

The earliest dengue outbreak in Bangladesh was documented in 2000, with a total of 5551 cases and 93 fatalities registered.<sup>11</sup> Afterwards, dengue has established itself as a prevalent and recurring occurrence in Bangladesh.<sup>1</sup> For instance, using data from 200 inpatients, Islam et al. examined a dengue epidemic that hit Bangladesh in 2002.<sup>12</sup> Viral isolation and molecular characterisation were among the laboratory approaches used to confirm dengue cases. Phylogenetic analysis of the eight Dengue Virus Type-3 (DEN-3) strains found in the study showed that they are closely related to isolates found in Thailand in the 1990s. The results indicated that the circulating DEN-3 viruses were most likely brought to Bangladesh from nearby nations.<sup>12</sup> This epidemic brought to light the fact that dengue has been a major issue in Bangladeshi public health since the year 2000. From 2000 to 2003, all four serotypes (DEN-1-4) were identified in Dhaka metropolis, with a higher incidence of the DEN-3 serotype.<sup>13</sup> The incidence of dengue decreased significantly in subsequent years, reaching a minimum of 375 cases in 2014. Nevertheless, in the year 2016, approximately 6100 instances of dengue have been documented in Bangladesh.<sup>14</sup>

The reemergence of DENV-3 was detected in 2017, leading to a significant increase in dengue infections

starting from the onset of the monsoon season in 2018.<sup>15</sup> The number of newly reported dengue infections surpassed 10,000 in 2018. In 2019, there were 101,354 dengue cases and 164 dengue-related deaths reported in Bangladesh, making it one of the worst dengue epidemics in the country's history.<sup>1</sup> According to the Directorate General of Health Services (DGHS) of Bangladesh, a total of 100,201 confirmed dengue cases got admitted into hospitals in 2019 – 51,179 were reported in Dhaka city and 49,022 were reported in other parts of Bangladesh. This indicated a tenfold surge in the number of hospitalized cases compared to the most significant outbreak prior to 2019.<sup>10</sup> In 2020, Bangladesh recorded a total of 1405 cases of dengue, with just three deaths confirmed to be directly caused by dengue.<sup>16</sup> However, the number of dengue cases in 2021 was 28,429, with 105 deaths attributable to the disease.<sup>1</sup> During the COVID-19 pandemic, concurrent dengue and COVID-19 infections compounded and heightened problems were observed in the healthcare system due to unreadiness, inadequate facilities, and insufficient funding. As a result, country's greatest death toll of 81 cases documented in 2022.<sup>17</sup> Besides, a disturbing spike in dengue incidence and deaths in Bangladesh (110,224 cases of DENV infections and 528 deaths between January and August of 2023) was reported, which was very different from previous patterns; probable factors behind were the arrival of a new strain of dengue virus (DENV-4) and the delayed start of the rainy season.<sup>17</sup> The situation was further complicated by a concurrent outbreak reported at the Rohingya refugee camps in Cox's Bazar district in 2022.<sup>18</sup> Since then dengue cases and fatalities reached a record-breaking high in the country, with numbers still remain on an upward trajectory (as shown in Fig. 1).



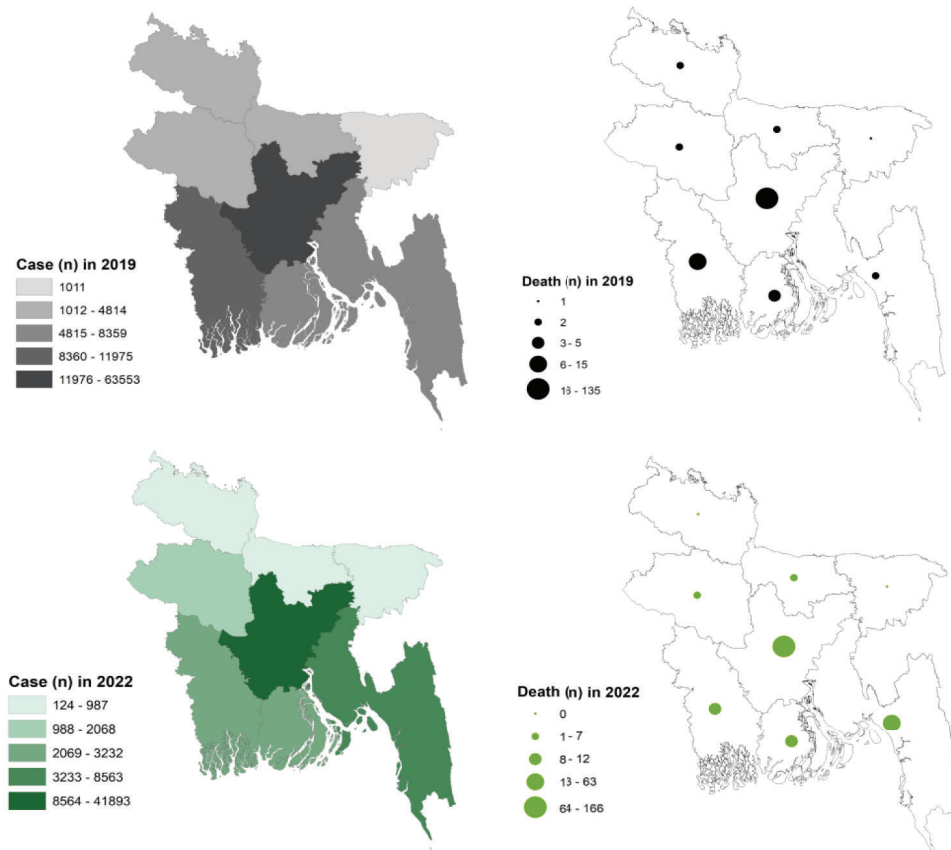
**Fig. 1.** Dengue cases and deaths connected to dengue fever reported in Bangladesh between 2008 and 2022 (Source: Kayesh et al.)<sup>1</sup>

**SOCIODEMOGRAPHIC TAPESTRY OF DENGUE**

Dengue fever was found positively associated with low socioeconomic position, low income, poor education, ignorance about dengue, unemployment, overcrowding in the home, substandard housing (including inadequate sewage and garbage disposal), and the kind of dwelling, as based on several research.<sup>19-24</sup> In addition, evidence showed that during dengue epidemics, men were more likely to get infected with the virus, while women were more likely to experience severe cases of the disease.<sup>25</sup> Another report on dengue in Bangladesh revealed that 73.33% of cases were between 18 and 40 years, affecting mostly young and economically active people. Only 15.24% and 9.52% of cases were found in the 41–60 years and <18 years age group respectively. Patients >60 years had the lowest percentage (1.90%). Dengue cases were similar across age groups, although more men were infected, suggesting a gender-related susceptibility. In addition, urban areas had a higher infection rate (54.35%) than rural areas.<sup>26</sup>

**MAPPING THE GEOGRAPHICAL DISTRIBUTION OF DENGUE**

Urban regions of Bangladesh are prone to dengue epidemics due to a combination of factors, including a dense population, unplanned development, lack of surveillance, and a lack of attention to dengue prevention measures. This problem is further worsened by climate change. As a result of better trade and communication, more people, including dengue patients, are able to travel, increasing the nationwide prevalence of dengue.<sup>18</sup> In 2019, the Dhaka division had the largest number of dengue cases, followed by the Khulna, Chattogram, Barishal, Rajshahi, Mymensingh, Rangpur, and Sylhet division. The Dhaka Division had the largest number of dengue cases in 2022, followed by Chattogram, Khulna, Barishal, Rajshahi, Mymensingh, Rangpur, and Sylhet. This indicates that the Dhaka Division, especially Dhaka city, was the epicentre of the outbreak<sup>1</sup> (as shown in Fig. 2).



**Fig. 2:** Dengue infection and fatalities associated with dengue documented in various regions of Bangladesh in the years 2019 and 2022 (Source: Kayesh et al.)<sup>1</sup>

## DENGUE SEROTYPE DYNAMICS AND DISEASE PATTERN

The four different serotypes of dengue fever (DENV-1 through DENV-4) are all found in tropical and subtropical areas worldwide.<sup>27,28</sup> The 2000 outbreak in Bangladesh saw the presence of all four serotypes of the dengue virus, with DEN-3 being the most prevalent.<sup>28</sup> In order to identify the dengue virus serotypes that were circulating, Another study, done between 2013 and 2016, showed that Dhaka contained both DEN2 and DEN1, while Chittagong and Khulna exhibited a predominance of DEN2. 2014 marked the expansion of DEN1 outside of Dhaka. Both DEN1 and DEN2 were circulating in 2015; however, by 2016, DEN2 had taken over as the most common strain in all three cities.<sup>15</sup> However, DEN-1 and 2 were the most common strain in the outbreaks between 2013 and 2016, whereas DEN-3 has isolated the outbreaks prior to 2002.<sup>15,28-30</sup> In 2017, the DEN-3 was observed to reappear, and in the recent past, DEN-3 and DEN-4 were more frequently observed.<sup>30</sup> The most common symptoms of dengue fever during the initial outbreak in 2000 were fever (100%), headache (91%), and joint pain (85%). In 2019, the dengue epidemic that was the worst occurred in Bangladesh. In addition to fever, gastrointestinal symptoms, particularly nausea and vomiting (69.2% of cases) and abdominal pain (84.6%), were the most common presentation.<sup>12,13,15,30</sup> In addition, around 25% of individuals in the 2019 outbreak had hypotension, which is a symptom of plasma leakage and imminent shock. However, a research that tracked paediatric patients from 2006 to 2008 found that shock symptoms were present in just 11% of events.<sup>31</sup> Hence, it is clear that dengue is likely experiencing an epidemiological change in Bangladesh, with a focus on more severe cases (dengue shock syndrome rather than dengue haemorrhagic fever). This shift may have been prompted by the recent comeback of the DENV-3 serotype.<sup>13,15,30</sup> In addition, A major public health concern for Bangladesh could arise from secondary infections caused by the resurgence of the DENV-4 serotype, which has been absent for over 20 years.<sup>13</sup>

## SEASONAL VARIATION, CLIMATE CHANGE AND URBANIZATION

The Aedes mosquito is a vector that is affected by climate change; spread of dengue in tropical and subtropical regions typically displays a seasonal pattern. This pattern is a result of the impact of climate on the disease's propagation cycle.<sup>32,33</sup> Moreover,

changes in average temperature and temperature fluctuations have a significant impact on the viability and population growth of the Aedes mosquito. They thrive during the day and are most effective in transmitting dengue fever when the diurnal temperature range (DTR) is near zero, which is around 29.3°C.<sup>21,34</sup> Because Aedes mosquitoes prefer to lay their eggs in man-made containers, which are more abundant in urban environments, rainfall and human population density are also relevant factors.<sup>35,36</sup> All of these are true for Bangladesh being situated in the South-East Asia region. Data showed a strong correlation between monthly humidity and dengue incidence, with the strongest impacts shown two months after the fact. Based on the study's projections, a significant increase in dengue incidence by 2100 could be caused by a rise in global temperatures.<sup>36</sup> Evidence on the influence of climate change through assessing vectorial capacity (VC) of Aedes aegypti mosquitoes under several climate scenarios demonstrated that despite a projected drop in yearly VC by the end of the century, the risk of possible dengue epidemic transmission remains high in all regions. The decrease in VC obscures notable fluctuations in monthly VC indicating a possible elongation of the dengue season throughout the entire year.<sup>34</sup> Evidence also showed that rising and fluctuating temperatures, uncontrolled and fast urbanisation, a high rate of population growth, and Bangladesh's weak medical infrastructure all contribute to the intensity and frequency of dengue outbreaks in the last couple of decades.<sup>10,21,30,34,36,37</sup>

Such risks of further outbreaks highlight the necessity of flexible public health planning, as climate change modifies the timing and geographical distribution of dengue risk in Bangladesh. This calls for the implementation of enhanced monitoring and control strategies to minimise the impact of future outbreaks.

## HEALTH BELIEF MODEL FOR DENGUE PREVENTION

The influence of information, values, and practices on dengue prevention and control is clearly apparent. The Health Belief Model (HBM) is widely utilized and consists of several key components: risk susceptibility, risk severity, benefits to action, barriers to action, self-efficacy, and cues to action.<sup>38</sup> Regarding dengue, the Health Belief Model (HBM) offers a framework for comprehending how to efficiently organize communications and impact behavioural

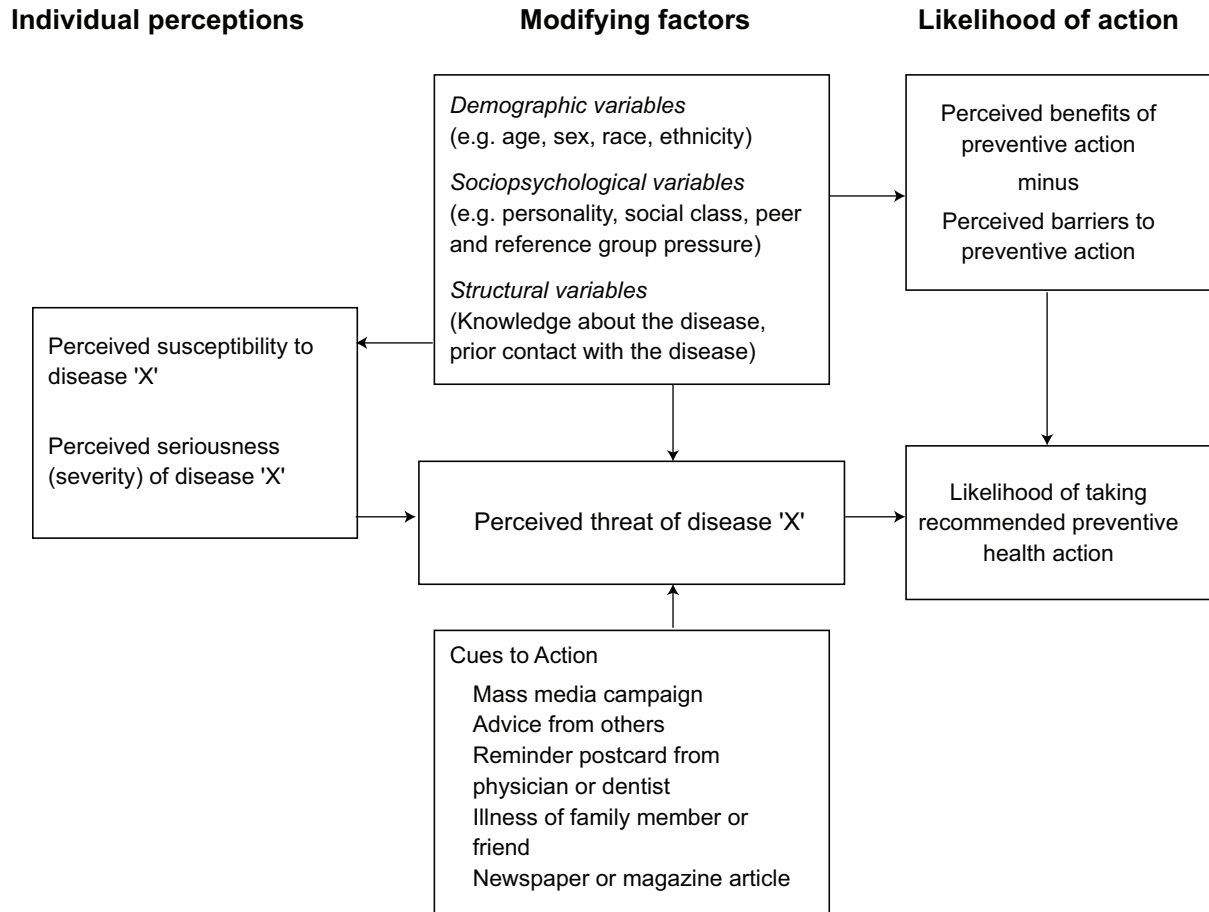


Fig. 3: Health Belief Model (Source: Roden)<sup>40</sup>

modification.<sup>39</sup> The HBM framework emphasises the necessity for focused interventions by highlighting a variety of beliefs. The HBM is supported by the positive association between knowledge/practices and attitude/practices, which suggests that raising awareness has a beneficial effect on preventative behaviours. It is imperative to tackle information gaps and psychological obstacles in order to customise Dengue prevention tactics and encourage a more all-encompassing community reaction.<sup>39,40</sup>

Since there is no vaccine for dengue fever available in Bangladesh, adopting healthy habits such as acquiring accurate knowledge, maintaining a positive mindset, and consistently following safe practices can contribute to the elimination of dengue fever.<sup>2,41</sup>

### INTERVENTION AND STRATEGIES

The mitigation of dengue issues in Bangladesh involves a synergistic approach that combines governmental endeavors with collaborative strategies.

Moreover, possible measures to be implemented consist of implementing statewide event-based dengue surveillance coupled with environmental management, conducting research on ecological, environmental, and entomological markers of infection, and creating geospatial and risk mapping to identify sensitive areas.<sup>41</sup> Unfortunately, even though dengue research is making great strides globally, it remains a significant challenge to provide effective treatment and prevention alternatives, making dengue management and prevention a pressing issue in Bangladesh today.<sup>5</sup>

Dengue outbreak prevention continues to rely primarily on vector control.<sup>1</sup> In Bangladesh, the city corporations/municipalities are in charge of mosquito management as part of its current vector-control mission. The main component of the programme is the use of insecticidal chemicals to kill adult mosquitoes. This is particularly important during the months of August and September, when hospitals often see a high number of dengue cases.<sup>42-</sup>

<sup>44</sup> Despite the implementation of vector control measures in the past decades, namely targeting mosquitoes and their breeding grounds, dengue remains a significant public health issue in Bangladesh. This might be due to a confluence of circumstances, such as the availability of vulnerable human hosts during the start of transmission seasons and favourable weather conditions (rainfall that coincides with higher temperatures). Based on previous evidence, it is recommended that the vector-control programmes need to be initiated in the month of April.<sup>44</sup> Nevertheless, it is believed that a mix of vector control schemes yields better results than any one method alone.<sup>42</sup> According to World Health Organization (WHO), a continuous engagement of the community is crucial in order to significantly enhance vector control endeavours.<sup>2</sup> Several pieces of evidence suggested that dengue cases may be significantly reduced with the implementation of community-based environmental management strategies, such as water container covers and house screening.<sup>45,46</sup>

Effective dengue prevention and control can be accomplished through the use of appropriate preventative measures, including the utilisation of mosquito nets, repellent spray, and mosquito coils; elimination of stagnant water; and avoidance of the accumulation of rubbish in and around residences to deter mosquito reproduction. In addition, community surveillance and enhanced awareness impact significantly in prevention and control of dengue-related morbidity and mortality in the community. It affects people's understanding of dengue, their perception of its severity and susceptibility, as well as their habits and beliefs.<sup>41,47,48</sup>

Finally, we recommend that emphasizing health education on dengue should be a priority for dengue management programmes focusing on healthy living, vector control, importance of early diagnosis and treatment and those will be run by local government and non-government organizations (NGOs) both in rural and urban densely-populated areas.

## CONCLUSION

Our analysis of dengue-related issues in Bangladesh uncovers a complex public health problem that requires a thorough and subtle strategy. Comprehending the development of healthcare systems and interventions is crucial, as emphasized by the historical perspectives and models of public health. Demographic views provide insights into

changes in population size and disease trends, highlighting the importance of implementing focused measures for protection and screening. An in-depth analysis of the values that shape policy making is required in order to address the ethical and ideological aspects of public health. Community development techniques and engagement tactics are seen as essential instruments, highlighting the significance of community involvement in enhancing health. Looking ahead, it is crucial to improve public health in response to the difficulties posed by dengue. Suggested measures involve enhancing community-based initiatives, incorporating behavioral change models into public health interventions, and promoting interdisciplinary collaboration. Furthermore, allocating resources towards conducting research to comprehend the specific circumstances of the region and applying enduring strategies can greatly enhance efforts to prevent and manage dengue in Bangladesh. By prioritizing these principles, organizations may work together to build a strong public health framework that is better equipped to handle Dengue problems and enhance the well-being of the community.

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