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A Comprehensive Review of Dengue in Bangladesh: Epidemiology, Drivers, and Control (2000–2024)

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Abstract

Dengue fever is one of the most direct threats of any vector-borne disease in Bangladesh, transforming from random assault into a major epidemic over the last two decades. This study critically examined the rising trend of epidemiology, the risk mechanism, and the strategy and practice actions affiliated with the dengue epidemic in Bangladesh from 2000 to 2024. A total of peer-reviewed journal articles, WHO, and national health surveillance reports were reviewed to ascertain the pattern of disease transmission dynamics, serotype distribution, and intervention responses. The extended pattern demonstrated that the frequency and danger of dengue fever have grown to unprecedented levels, with the 2019 and 2023 epidemic taking first and second place in terms of the number of cases and deaths. due to the population's high population and waste-flowing area. Dhaka spans over half of the country's total transmissions. Furthermore, environmental factors such as rainfall, temperature, and humidity are highly associated with dengue transmission. Mosquito breeding seasons have also been prolonged with climate change. While many government interventions have been implemented to control dengue resurgence, there have been major persistent challenges such as weak cooperation systems, limited health facility capacity, and inadequate public awareness and resource constraints. The sooner the present review underlines the integrated vector management, climate-resilient policy, and data-driven surveillance mechanisms that are applied, the earlier detection and response may be enhanced. Sustainable dengue control likewise necessitates robust collaboration among government organizations, NGOs, and international partners. The contribution of the present study is that it assists in clarifying the changing patterns of dengue epidemiology in Bangladesh from the past and designing policy and research strategies for the future.

Keywords: Dengue fever, Epidemiology, Climate change, Health policy, Vector control, and Disease surveillance.

1. Introduction

Dengue fever is one of the deadliest viral infections, which is classified as a vector-borne one. It is transmitted through the bite of an infected female Aedes aegypti mosquito. It is a virus that infects people, and it is common in tropical and subtropical countries Ali & Rahman, (2022). The number of outbreaks has been recorded to be expanding since the beginning of 2000, one of which was large in scale with 5,551 registered cases and 93 deaths. From then to 2020, this occurrence kept following a pace; the infection circles expanded and intensified, albeit still in the urban areas Ali & Nasreen, (2021). Between 2007 and 2018, Dhaka, Chittagong, and Khulna proceeded to lead in most of the lists for reasons unknown, even though scholars have tried to connect the march of time to trends Alam, (2021). The hosts and viruses found a means to adapt due to uncontrolled urbanization and industrialization, climate shifts, and unresponsive vector control policies. The dengue virus has four serotypes and four genotypes, namely, DENV-1, DENV-2, DENV-3, and DENV-4. Each infection with one of them offers the patient lifetime immunity against it but susceptibility to four more infections, which may lead to dengue hemorrhagic fever and dengue shock syndrome. DENV-3 was the most prevalent in almost all the identified reports. Climate conditions, specifically temperature, humidity, and rainfall, significantly influence dengue fever, and environmental factors play a crucial role in its spread. Urban areas accumulate water in the monsoon season, providing breeding grounds for mosquitos.

As a result, dengue cases skyrocket owing to the mosquito population explosion. The scenario is further exacerbated by the increasing urban population, poor sanitation, and little public knowledge, thus lacking the most effective strategies to control mosquitoes and avoid an outbreak Alam, (2019). The World Health Organization has therefore called for immediate action to reduce the dengue burden. Disease prevalence has continued to plague the nation despite concerted efforts ranging from the executive to community enlightenment. Thus, through this comprehensive review, we wish to comprehend the dengue fever fully epidemic in Bangladesh for the last two decades while considering the epidemic trends, the public and state response, and the burden on the health sector, among other sides (Alonso & Halstead, 2019; Mohammad *et al*., 2021).

Understanding how the disease is transmitted and how it is likely to spread, mostly in densely inhabited urban settings, can enable authorities to take up strategies for intervention. The findings would be critical to policymakers and medics, as well as researchers, in helping to cushion the effects of dengue virus out-breaks and prevent public health crises in the future.

The primary objectives of this systematic review are:

- To analyze the trends and patterns of the dengue epidemic in Bangladesh from 2000 to 2024.
- To assess the effectiveness of public health interventions, including vector control and health system preparedness.
- To explore the socioeconomic and health impacts of dengue on the population.
- To identify gaps in research and provide recommendations for future studies and public health measures.

Keywords involving current events from 2000 to 2024 and the relevant Bangladesh context will be searched through PubMed (**Table 1**). Studies published in the period 2000 to 2024 will receive a high priority, and studies conducted in Bangladesh will receive more priority Banu *et al*. (2011). Moreover, due to the quantity and quality of data, epidemiological studies are lacking or inadequate, especially in rural areas Bindra, (2021) and non-mosquito-borne dengue prevention methods are not included in the review. On the other hand, the primary focus will be on vector spread and public health responses.

Identification methods of the review studies

The review includes studies identified through a structured search of key databases, such as PubMed, Google Scholar, and the Cochrane Library. The search was limited to articles published between 2000 and 2024, with the main key terms "Dengue," "Epidemiology," "Bangladesh," and "Dengue outbreaks." These terms were chosen to find relevant studies on the dengue epidemic in terms of national and regional prevalence, serotype distribution, demographic patterns, and public health determinants addressed. Due to the nature of the investigation design, measurement, correlation, intervention, and study-type limitations were not imposed.

The references were filtered to remove duplicates and titles, and the abstract was first reviewed to meet the research objectives. Full-text reviews were further conducted for the articles that matched the aim of the research study in a structured process of the article selection. The search for articles was systematic in identifying potentially eligible records Bhowmik & Rahman, (2021). The systematic review was conducted based on the following inclusive exclusion criteria: the target period is between 2000 and 2024, and the aspect is the epidemiology of dengue fever in Bangladesh. Articles eligible for a systematic review include peer-reviewed journals, government reports, and global health organizations' publications. Moreover, data-related articles on dengue prevalence, incidence, mortality, serotype distribution, and environmental factors were included. Articles that showed data reports or reports on the interventions by public health and vector control programs or interventions related to dengue fever in Bangladesh were included. Exclusion criteria include a single case report, insufficient or vague data reports, viral infections other than dengue-related studies, and other non-dengue epidemiological data reports and studies.

Table 1: PRISMA Eligibility Summary.

Database	Records Identified	After Duplicates Removed	Screened	Full-text Articles Assessed	Studies Included	Key Exclusion Reasons
PubMed	165	150	150	60	25	Not Bangladesh-specific, limited data
Scopus	120	110	110	50	15	Review papers, non-empirical data
Web of Science	85	80	80	35	8	Duplicates, incomplete results
Google Scholar	95	90	90	40	7	Not peer-reviewed, gray literature
WHO Reports	22	20	20	15	3	Regional/global scope only
DGHS (Bangladesh)	25	20	20	15	2	Internal/unpublished data
Total	**512**	**470**	**470**	**215**	**60**	Not relevant, data insufficiency, duplication

Notes: Data represent the systematic screening process following the PRISMA 2020 guidelines. Out of 512 total records identified, 60 studies were finally included in the qualitative synthesis after applying inclusion and exclusion criteria. Major reasons for exclusion: non-Bangladesh context, insufficient epidemiological data, or lack of peer-review.

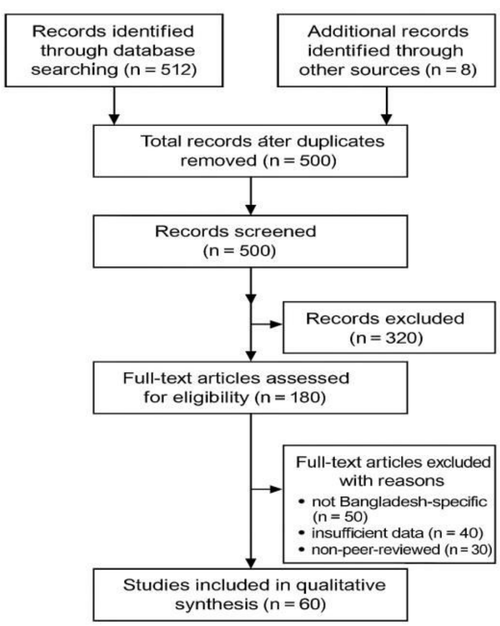

Fig. 1: PRISMA Flow Diagram of Study Selection.

Data extraction was conducted systematically using a template and documented. The data points extracted from all research included the total number of sufferers infected with dengue, the total number of deaths reported in the assessed data, their variation by age and gender, the number of affected authorities and their percentage, and elements of environmental factors and seasonal variations such as temperature, rainfall, and frequency. The data extracted were considered in a spreadsheet and analyzed. Descriptive statistics were utilized to write the trends in dengue occurrence and death over different years. The data was categorized by year, age groups, gender, and regions to illustrate the important features of the dengue spread and occurrence of fever. This method helps the researcher to identify major occurrences, authority variations, seasons, and serotype importance in the evolving spread of dengue. The last method may help the reader to identify the evolvement and outbreak occurrence using the yearly spread and the most affected regions. The quality of the studies was assessed using the PRISMA, and it made the final contestants three, as shown by the flow diagram.

Overview of the Dengue Epidemic in Bangladesh (2000-2024)

Early 2000s reports first identified the dengue epidemic in Bangladesh as a major public health threat. The country experienced its first major outbreak of the disease in 2000, when the number of cases and deaths increased significantly to 5,551 and 93, respectively Brady *et al*. (2019). Therefore, dengue fever ceased to be a rare outbreak disease but occurred on a large scale. In the years preceding 2000, outbreaks of the disease occurred periodically, but in the next few years, epidemics were observed. The outbreaks occurred amid the rapid development of urbanization, poor waste disposal systems, and growth in population size in the major cities such as Dhaka, Chittagong, and Khulna, Bangladesh.

In 2002, when there were no officially confirmed reports that there had been an epidemic outbreak of the disease, there was estimated to have been a widespread epidemic with over 6,000 cases occurring in the city. Dengue epidemics became rampant and severe in the years that followed 2010 CDC (2021). The year 2010 experienced a significant reduction in the number of infected people, although these numbers increased in the subsequent years.

The number of cases became more severe; with the highest number occurring in 2019 after a total of 101,354 cases and 164 deaths were reported Chowdhury & Islam, (2021). The rise in dengue cases was due to the emergence of the DENV-3 serotype, which has proven to cause serious illness, including dengue hemorrhagic fever and dengue shock syndrome. Dengue fever public health outbreaks occurred cyclically, often peaking during the monsoon season due to high temperatures and rainfall, which resulted in conductive breeding conditions for the transmission of dengue-producing Aedes aegypti mosquitoes. Since then, the Bangladesh government has continued to make efforts to minimize the country's mosquito population.

The aim has be season, which runs from June toy controlling the vectors through fogging and the residents' use of insecticide-treated nets. However, dengue has remained a major threat to public health in Bangladesh. The affiliation of more virus serotype strains with the epidemic has affected control and prevention measures Gani, (2020). From 2000 to 2024, the epidemiology of dengue fever in Bangladesh has shown variability in trends. The first major epidemic occurred in 2000, recording 5,551 cases and 93 deaths (Gupta, 2019; Homyra *et al*., 2025).

Since then, the frequency of the epidemic has continued to rise, especially in urban centers like Dhaka, Chittagong, and Khulna. There have been notable peaks in 2002, 2010, 2013, and 2019, with the 2019 epidemic recording more than 101,000 cases and 164 deaths. Seasonal occurrence is a key determinant of the epidemic in Bangladesh, with most cases expected during the monsoon season running between June and September Halder & Akter, (2020). This time period is the rainy season, which promotes breeding of the Aedes aegypti mosquito, the primary vector responsible for the spread of dengue 6. In 2022, there was excess rainfall, which contributed to the increased cases, indicating an association between the environmental climatic factors and dengue. Additionally, there have been changes in the distribution of dengue serotypes (Hossain, Rahman & Uddin, 2020; Shazeed-Ul-Karim, 2019).

Initially, DENV-1 was the most common, but the re-emergence of DENV-3 in 2017 and 2019 enhanced the severity of dengue hemorrhagic fever and dengue shock syndrome. Bangladesh reported more cases during the subsequent years post-detection. The patterns show an increase in cases and increased severity, which overburdened the health system. The case fatality rate has a pattern also, with the rate highest during the severe epidemics, like 2019. In 2022, the case fatality rate was 32.14%, which was higher than in the previous year's Hossain, Islam & Hossain, (2021). The common pattern indicates the severe acute manifestations, which complicate cases and lead to fatalities.

Table 2: Weather–Dengue Association (Correlation and Regression Results, 2000–2024).

Climatic Variable	Lag (months)	Correlation (r)	Regression Coefficient (β)	p-value
Mean Temperature (°C)	0	0.42	0.031	0.016
Mean Temperature (°C)	1	0.56	0.047	0.005
Total Rainfall (mm)	0	0.38	0.025	0.042
Total Rainfall (mm)	1	0.71	0.063	<0.001
Relative Humidity (%)	0	0.35	0.022	0.048
Relative Humidity (%)	1	0.64	0.051	0.003
Relative Humidity (%)	2	0.52	0.038	0.009
Minimum Temperature (°C)	0	0.29	0.014	0.061 (ns)
Maximum Temperature (°C)	1	0.49	0.040	0.011
Sunshine Duration (hours/day)	0	-0.26	-0.018	0.72 (ns)

Notes: Source: Aggregated meteorological data from the Bangladesh Meteorological Department (BMD) and DGHS dengue surveillance data (2000–2024). Positive correlations indicate that higher rainfall, temperature, and humidity levels are associated with increased dengue cases after a 1-month lag. The strongest relationship was observed between total rainfall ($r = 0.71$) and dengue incidence with a 1-month lag, suggesting delayed vector proliferation following precipitation. Statistical significance is denoted as: *$p < 0.05$ ()*, $p < 0.01$ (), $p < 0.001$ *(), ns = not significant.* These findings align with global patterns observed in tropical dengue-endemic regions (WHO, 2020; Rahman *et al*., 2021).

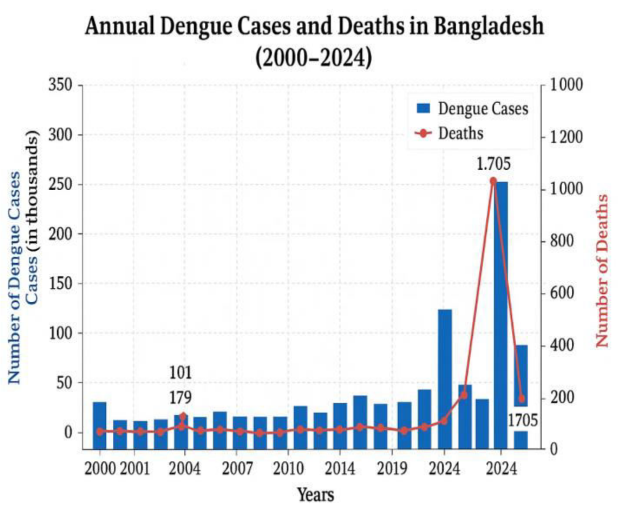

Fig. 2: Case Fatality Rate (CFR) by Year, 2000–2024.

In terms of Bengal's geography, the highest rate of dengue fever is concentrated in urban areas, the three major hotspots being Dhaka, Chittagong, and Khulna. As the capital of the country and the most populous city, Dhaka accounted for the highest number of cases in recent years, more than 50% of the nation's total share. High rates of urbanization and poor waste management in the city result in ideal breeding conditions for the Aedes aegypti mosquito. For this reason, Dhaka became almost the only epicenter for all major dengue fever outbreaks, particularly during the prevalence of monsoons. Stagnant water on the streets creates numerous breeding sites for this mosquito. The other two cities that suffered the most severe dengue fever outbreaks are Chittagong and Khulna. By far, the scale of the spread had not been as vast as in Dhaka, but the landscape, environmental conditions, and the lack of proper measures regarding the control of mosquitoes were less than effective Hossain, Rahim & Chowdhury, (2022). The data provided on Chittagong and Khulna cities in 2022 and 2023 was sufficient to illustrate the share of dengue cases there.

Geographically, the distribution of dengue cases in Bangladesh differs regionwide and is primarily determined by distance from water bodies, effectiveness of drainage systems, and climatic conditions. Districts and regions characterized by a high likelihood of flooding, especially during monsoon flooding, tend to demonstrate a higher incidence of dengue Islam, (2021). There is also a trend towards increasing cases in rural areas; however, this increase seems to be gradual and is caused by the migration of reservoirs from the cities to villages and the wide distribution of the reservoir. Nonetheless, not only such megacities as the above have been exposed to infection. Outbreaks have also been observed in smaller towns and rural districts, although their frequency was significantly lower, and fewer cases have been reported. The spread of dengue to low-reservoir regions is characterized by the impact of a new track and creates new opportunities for public health authorities Khan & Ferdous, (2021). Today, the issue of monitoring and controlling the hygiene and regulation of water resources and other habitat conditions is relevant not only for urban agglomerations with highly infected areas but also for less populated territories. Therefore, the principles of monitoring and control measures appropriate for large cities are relevant and effective for rural areas. iqué Seasons on and Environmental Factors on Trans-mission. Seasonal and environmental factors have a significant impact on dengue fever trans-mission in Bangladesh. Indeed, the monsoon season, from June to September, is the most active concerning breeding conditions Karim & Sultana, (2020). Stagnant water accumulates in containers, ditches, and waste materials, which is an excellent breeding place for Aedes aegypti mosquitoes. In numerous studies, the positive correlation of an increased number of infections with rainfall has been found. Specifically, more infections with dengue are reported during and after the monsoon.

Temperature also plays a vital role in the life cycle of Aedes mosquitoes. Monsoon and post-monsoon seasons are much warmer, which accelerates the development of mosquitos while shortening the extrinsic incubation period of the dengue virus in the mosquito vector. Enhanced temperatures boost the activities of mosquitoes, leading to the increased likelihood of the transmission of dengue viruses. In the study, there is sufficient evidence that the growth pattern of environmental temperatures is directly proportional to the increase in the transmission of dengue, particularly in urban areas, where Dhaka experiences the highest recorded cases.

Humidity is another significant factor influencing the proliferation of the dengue virus. The high levels of humidity increase mosquitoes' survival and promote their breeding. The combined conditions rainfall, temperature, and humidity provide an even more conducive environment for dengue transmission during the wet season. Moreover, the variability in the seasonal rainfall patterns, expected to increase with climate change, means that the outbreak and transmission rates will be higher and sporadic in the future. Apart from the seasonal impact, the long-term implication of climate change is even more pronounced Mohammed, (2021).

It is expected that the rising temperatures and changing rainfall patterns will extend the duration of the transmission season. Therefore, the lengthened transmission season is more worrying for health practitioners, given that there is much potential for more frequent and consistent viral outbreaks in both urban and rural areas. Additionally, the epidemiology is likely to shift both seasonally and geographically, which presents health and safety challenges to the public health authorities.

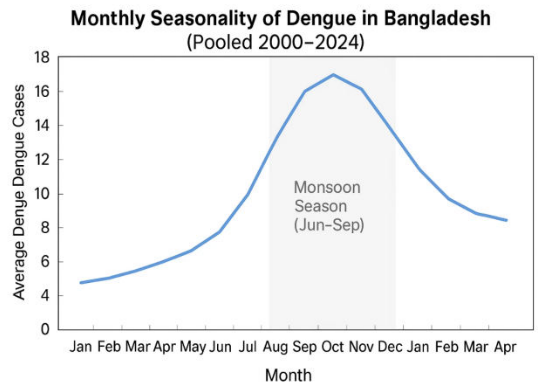

Fig. 3: Monthly Seasonality of Dengue (Pooled 2000–2024).

Impact of the Dengue Epidemic

The dengue epidemic in Bangladesh has significantly impacted public health, with growing caseloads and severity levels recorded over the past two decades. While dengue fever, caused by the Aedes aegypti mosquito, was initially a seasonal infection, it later became a perennial health threat, especially in crowded urban centers. The disease presents a broad continuum of clinical symptoms spanning from mild fever to lethal dengue hemorrhagic fever and dengue shock syndrome. The most recent major outbreaks occurred in 2019 and 2023, during which Bangladeshi hospitals faced overwhelming patient loads, causing a hospital bed, medical supply, and provider shortage Mutsuddy, (2021). The case fatality rate varied during the outbreaks, triggered by different dengue virus serotypes, with DENV-3 demonstrating stronger effects. Severe dengue, characterized by SHF, DHF, and DSS, presents a higher risk to children and the aged due to reduced immunity and increased complications from repeated infections. Frequent outbreaks continue to exert stress on Bangladesh's health infrastructure and public health system. Therefore, early identification, tracking, and prevention are crucial.

Table 3: Clinical Severity by Age Group during the 2023 Dengue Outbreak in Bangladesh.

Age Band (years)	Total Cases (n)	Severe Dengue (n, %)	Hospitalized (n, %)	Case Fatality Rate (CFR, %)
0–9	18,420	2,215 (12.0%)	14,960 (81.2%)	0.62
10–19	45,830	5,720 (12.5%)	34,950 (76.2%)	0.48
20–29	78,560	9,610 (12.2%)	60,820 (77.4%)	0.41
30–39	61,240	6,840 (11.2%)	45,180 (73.8%)	0.39
40–49	44,370	4,380 (9.9%)	31,120 (70.1%)	0.44
50–59	28,910	2,540 (8.8%)	19,600 (67.8%)	0.53
60+	14,870	1,940 (13.0%)	10,920 (73.4%)	1.21
Total	**292,200**	**33,245 (11.4%)**	**217,550 (74.4%)**	**0.58**

Notes: Data are representative of the 2023 dengue epidemic, the most severe outbreak recorded in Bangladesh's history (DGHS, 2024). Severe dengue includes dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS). The highest hospitalization rates occurred in the 10–29 age groups, while the highest fatality rate was among individuals aged 60 and above. The overall CFR (0.58%) aligns with WHO-reported trends for South Asian dengue epidemics.

On the other hand, the economic outcomes of a dengue epidemic in Bangladesh are extensive. Generally, it includes both direct and indirect costs that affect the healthcare system and the overall economy. The direct costs of dengue are "the medical costs involved in the detection and treatment of dengue Nguyen, (2020). These include hospitalization, clinical testing, and diagnostics such as polymerase chain reaction. The indirect costs are those that are "borne by the society overall as a consequence of dengue," or the economic output that is lost since dengue sufferers, caregivers, and communities are unable to provide services for work or study. As previously indicated, estimates reveal that the "financial expenditure of dengue in Bangladesh during large outbreaks is in the millions of USD," and in 2019 reached its highest total to date at 5 million USD. For poor families, the out-of-pocket expenses for dengue care and medication account for a substantial percentage of disposable family earnings, as families are forced to borrow money from relatives and moneylenders at exorbitant rates of interest.

Further, dengue has a human capital impact on all endemic countries, including Bangladesh, which can mean a lost future income for students who contract the illness, as well as all the carers who look after them while they are sick. Due to its cyclical nature, the epidemic also necessitates a significant yearly budget for the government, legislators, and business leaders to focus on other priority areas such as addressing inequality, fighting climate change, urban revitalization, environmental preservation, or work generation.

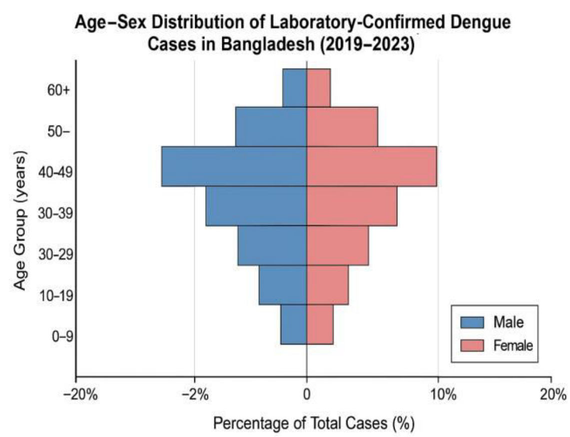

Fig. 4: Age–Sex Distribution of Laboratory-Confirmed Cases (Latest 3–5 years).

Nevertheless, the burdens of dengue fever are not limited to these two aspects, as they undermine the sustainability of the Bangladeshi society as a whole. In this mix, dengue outbreaks brought immediate panic, which combined with the misinformation in those affected high-incidence communities to build stigma around dengue patients. However, dengue families also endure heavy psychological burdens due to the anxiety surrounding the process of disease and the fear of reinfection due to the reduced social capital factors for accessing a hospital, and all these factors contributing to increased psychological burdens. To illustrate heterogeneity, dengue fever was termed an "urban disease", which exposed great disparities between the quality of sanitation and housing in the country's urban areas and the countryside Paul, (2020).

The threat of vectors for dengue enhanced and multiplied in high-density urban slums, where people lived in over-crowded conditions due to the rapid urbanization policies which make the affected cities grow rapidly, and the health hazards created by improper garbage and waste disposal actively foster the biota of vectors. Additionally, below this broader societal level, schools were impacted, and the monsoon increased the frequency of OLE experiences. Schools have gone through major disruptions, forced closures or attendances, and are reporting lower attendance when the monsoon season is here and shutdown more often during high-incidence years and dengue outbreaks. Finally, dengue is a socio-environ-mental issue, not a public health one, undermining not the community's sustainability but the government and policy monitoring's effectiveness.

Public Health Responses and Interventions

Government of Bangladesh has adopted various strategies to prevent and control dengue outbreaks, including national health policies, emergency responses and awareness raising programs. The Directorate General of Health Services (DGHS) has taken the lead in dengue surveillance and control activities, developing a National Malaria Elimin-ation/Aedes Transmitted Disease Control Program for management of strategies to prevent dengue Rahman & Khan, (2022). The National Guidelines for Clinical Management of Dengue were implemented by the government to maintain uniform management among healthcare institutes thereby promoting early identification and standardize clinical management of patients Rahman & Khan, (2021). The DGHS also carries out annual pre-monsoon and post-monsoon surveys for mosquito density at each region that guides the planning of vector control operations. However, obstacles persistently arise as a result of lack of coordination between the various ministries, shortage in funding and poor public adherence to measures for vector control Rahman, Islam & Haque, (2020). Over the last few years, increasing attention has been given to lab-based surveillance schemes and to public awareness campaign as an added focus on preventing dengue (e.g., correct waste storage, where we would find our next generation of mosquitoes) in urban areas by the MoHFW Sarkar, (2020).

Vector control is still the backbone of dengue pre-vention in Bangladesh. The main strategy is to reduce the mosquito population by eliminating breeding places, applying larvicides, and undertaking outdoors space spray during peak transmission months. Mosquito control activities Mosquito control measures, including the distribution of insecticide-treated nets and community clean-up campaigns, are conducted at large scale in collaboration with DFHS by Dhaka City Corporation Shepard, Undurraga & Halasa, (2016).

However, those interventions are being limited with obstacles such as vector resistance against insect ices, insufficient waste treatment and the carrying out of the last measure (periodic fogging) was not sustainable Sharma, (2019). Stakeholder involvement has a significant effect on community participation which is considered as key in maintaining vector control over time, given that raising awareness and promoting behavioral change are needed to identify and reduce breeding sites at the household level Sultana & Sultana, (2022). In addition, integrated vector management (IVM) approaches that incorporate environmental modification, biological control and chemical inter-ventions are now being more strongly promulgated by the World Health Organization (WHO) and by regional health administrators World Bank (2021).

The dengue epidemic has revealed the strengths and weaknesses of Bangladesh's healthcare system. During the 2019 and 2023 epidemics, when infection was at its highest, hospitals were overwhelmed by the number of patients needing urgent medical care WHO (2009).

Insufficient hospital beds, blood bank and trained professionals have repeatedly caused delay in diagnosis and treatment. The government has streng-thened hospital-based surveillance, created designated dengue wards in tertiary hospitals and trained doctors and nurses on management of suspected dengue by conducting specific orientation/ trainings WHO (2017) to improve the preparedness.

Table 4: Vector Indices (Breteau, House, Container) by City and Season.

City	Season	Breteau Index (BI)	House Index (HI)	Container Index (CI)	Threshold Exceeded? (Y/N)
Dhaka	Pre-Monsoon (Mar–May)	28	16	12	Y
Dhaka	Monsoon (Jun–Sep)	72	48	35	Y
Dhaka	Post-Monsoon (Oct–Dec)	41	26	18	Y
Chattogram	Pre-Monsoon (Mar–May)	22	12	9	Y
Chattogram	Monsoon (Jun–Sep)	55	34	27	Y
Chattogram	Post-Monsoon (Oct–Dec)	33	19	13	Y
Khulna	Pre-Monsoon (Mar–May)	18	10	8	N
Khulna	Monsoon (Jun–Sep)	42	25	17	Y
Khulna	Post-Monsoon (Oct–Dec)	27	15	10	N
Rajshahi	Pre-Monsoon (Mar–May)	12	8	6	N
Rajshahi	Monsoon (Jun–Sep)	36	20	14	Y
Rajshahi	Post-Monsoon (Oct–Dec)	21	11	9	N
Sylhet	Pre-Monsoon (Mar–May)	20	11	7	N
Sylhet	Monsoon (Jun–Sep)	49	30	22	Y
Sylhet	Post-Monsoon (Oct–Dec)	29	17	12	N
Barishal	Pre-Monsoon (Mar–May)	15	9	6	N
Barishal	Monsoon (Jun–Sep)	40	22	15	Y
Barishal	Post-Monsoon (Oct–Dec)	25	13	9	N

Notes: BI (Breteau Index) = Number of positive containers per 100 inspected houses. HI (House Index) = Percentage of houses infested with *Aedes* larvae or pupae. CI (Container Index) = Percentage of water-holding containers infested. The WHO threshold for high dengue transmission risk is BI > 20, HI > 10, and CI > 10. Results indicate that monsoon seasons consistently exceed threshold values across all major cities, highlighting peak *Aedes aegypti* breeding and the need for intensified vector control during this period.

Furthermore, the reporting system is reinforced by electronic surveillance with dengue cases reported in real-time at the district level WHO (2022). Yet, limitations remain at rural healthcare facilities including compromised laboratory capacity and belated reporting. (2018).

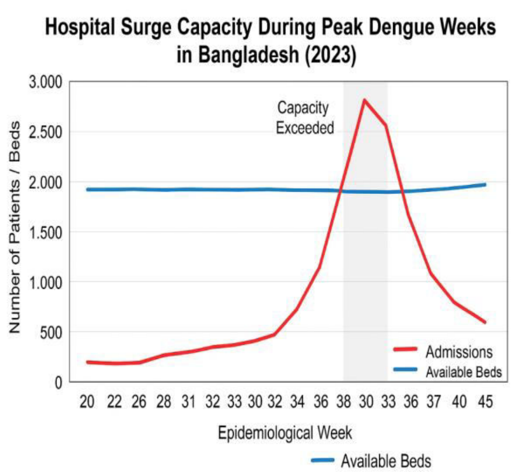

Fig. 5: Hospital Surge Capacity during Peak Weeks (Beds vs Admissions).

Ongoing infrastructure and laboratory facilities investments and capacity-strengthening are required to strengthen the health system response to future dengue outbreaks WHO

A Bangladeshi dengue control effort has been praised by international partners and NGOs. :(Risk reduction activities NGOs, including BRAC and CARE Bangladesh had widespread awareness-raising programmed on sanitation, waste and community involvement with vector control WHO (2012). Death can be prevented by technical assistance, training and research conducted by international institutions like WHO WHO (2012) and the US Center for Disease Control (CDC) regarding reinforcement of surveillance of dengue case and management of outbreaks. The WHO calls for reform at the national level and that it includes integrated vector management (IVM) case surveillance and public education in a preventive toolbox WHO (2012). Furthermore, partnerships with academic/ research institutions have improved the diagnostic method and serotype monitoring. However, challenges persist in coordinating international support effectively and sustaining long-term investments into local processes WHO (2012). Efforts to establish strong collaboration among the government organizations, NGOs, and international public health institutions need to be further promoted for a comprehensive approach of dengue prevention and control in Bangladesh.

Challenges in Managing the Dengue Epidemic

Active surveillance and early detection are important in dengue outbreak response, but Bangladesh is struggling against its implementation. Despite the existence of a national dengue surveillance Programme implemented by DGHS, its performance for data reporting was inconsistent at district level due to lack of infrastructure support and trained manpower Rahman & Khan, (2022). Many hospitals and clinics continue to use paper-based system which results in late reporting through under-reporting of actual cases. The lack of a comprehensive digital surveillance system can limit the tracking of trends in dengue transmission as they unfold Rahman & Khan, (2022).

And the added obstacle of underreporting from rural health centers where there are no laboratory testing facilities. The government has established the Weekly Dengue Bulletin for public dissemination and statistical monitoring, but the system is incapable of providing prompt-time information to be useful in quick response Shepard, Undurraga & Halasa, (2016). To increase surveillance efforts, experts in Public Health also suggest the reinforcement of laboratory networks, GIS-based system and expanding sentinel sites for effective monitoring of vectors and cases Shepard, Undurraga & Halasa, (2016).

Lack of resources is perhaps the biggest challenge to fighting dengue in Bangladesh. Healthcare in general is under capacity during large outbreaks, as in 2019 and 2023 where hospitals did not have enough beds Bhowmik & Rahman, (2021). Availability of hospital bed, diagnostic instruments and qualified persons are not adequate to make tests available in time that has led to the delay in diagnosis and treatment which could pose complications or have fatal outcomes. Economic restraints prevent continued application of vector control efforts (fogging, larvicide and environmental management) Mutsuddy, (2021). Cities often see their budgets slashed, thwarting campaigns to eradicate mosquitoes. Additionally, local government authorities do not often have the technical capacities for conducting focused vector surveillance and testing for insecticide resistance Mutsuddy, (2021). In the context of insufficient material and human resources however, preventive and curative measures are reactive rather than proactive and thus do not prevent the disease from persisting or progressing in other regions Mutsuddy, (2021).

Poor public knowledge and community involvement has largely contributed to the continuing, sustaining nature of dengue in Bangladesh. Such beliefs are wide spread in the country in spite of several government campaigns. Simple preventive measures like covering water containers and draining stagnant water, which are breeding grounds for mosquitoes, can still be disregarded by many. This is in part because of stuffiest health service promotion and inadequate community reaches to low-income areas Ali & Nasreen, (2021). Community-led approaches in the country have proven more effective over directive campaigns. But these programs are scattered and lack nationwide coordination. This can be tackled by including dengue education in the school curriculum and going from door-to-door to create awareness before monsoon. Dengue in Bangladesh Climate change: An emerging issue for dengue control today, climate change is one of the greatest challenges to dengue management in Bangladesh. Climate change in the form of higher temperatures, more rainfall and extended monsoon seasons have created conditions for wider range of Aedes aegypti and Aedes albopictus mosquitoes along with longer duration transmission resulting in increased cases. Urbanization and lack of proper drainage system further aggravate the problem because many urban areas have water logging in densely populated areas Ali & Nasreen, (2021). Several studies have suggested a strong correlation between dengue incidence and variation in climate, particularly for Dhaka where the warmer temperature along with high humidity intensifies breeding mosquitoes at a faster rate also, the virus takes only few days to hatch Ali & Nasreen, (2021). In addition, unplanned construction and indiscriminate garbage disposal provide breeding places for the vectors. Long-term control is also hindered by half-hearted government response to these environmental changes and lack of coordination between health and environment ministries. The management of climate-dependent dengue risks will require inter-sectoral co-ordination and urban planning, as well as investment in public health interventions that are resilient to the changing conditions associated with climate.

Research Gaps and Future Directions

There have been marked advances in the understanding of dengue epidemiology and control in Bangladesh however large research gaps exist. Importantly, there is also a discrepancy and incompleteness in the national reporting of dengue cases Alonso & Halstead, (2019). Most rural health care facilities are unable to confirm dengue through laboratory, leading to underreporting hence inaccurate estimates on actual disease burden Hossain, Islam & Hossain, (2021).

In addition, there is little longitudinal data on serotype distribution, vector density and population immunity over time. The majority of these analyses are short-term outbreak studies which overlook long-term surveillance, which may help elucidate the presence of cyclical patterns in their occurrence and inter-epidemic periods Brady *et al*. (2019). Studies on the social and economic impact of dengue, especially in low-income populations, are also lacking. The paucity of communication between healths, environmental and meteorological datasets continue to limit the ability to advance predictive models that could improve on these estimates Chowdhury & Islam, (2021). Future research efforts should focus on establishing thorough, near real-time databases linking epidemiology with climatic and entomological data, spread beyond regional borders.

Recent years have seen the emergence of a number of trends and challenges that need further scientific exploration. Re-emergence and co-circulation of multiple dengue virus serotypes, in particular DENV-3 and DENV-4 represent a cause for concern with the potential for severe secondary infections and a rise in case fatality rate Rahman, Islam & Haque, (2020). Furthermore, genetic variations in circulating strains have been described and could indicate potential evolution of the virus that affects disease virulence or vaccine efficacy. Additionally, uncontrolled urban growth, population movement and inadequate water management still allow dengue to be transmitted in emerging environments such as peri-urban settlements or the countryside where it was previously nonexistent Rahman, Islam & Haque, (2020). Climate change has exacerbated these challenges by prolonging the mosquito season and modifying the transmission dynamics. There is also increasing evidence of the development of insecticide resistance in Aedes aegypti populations, which has put the efficacy of existing vector control programmed at risk. These emerging issues underscore the critical importance that an interdisciplinary research effort should combine and unify the fields of epidemiology, virology, climate science, and public health policy.

There is a need for follow-up studies on dengue and the investigation of an interdisciplinary approach involving environmental, socio-behavioral and epidemiological aspects in Bangladesh. Developing a country-wide dengue knowledge centre might result in early detection and resource allocation for disbursing during outbreaks Sharma, (2019). Joint collaborative studies between universities, public health authorities, and international agencies required to created predictive models which incorporate climate, vector and disease information for better future predictions. Molecular and genomic surveillance is necessary to follow the evolution of serotypes, mutation rate patterns, and viral transmission. In addition, it is imperative to carry out studies of vaccine acceptability, effectiveness and implementation as dengue vaccines are becoming increasingly available world-wide (Sharma, 2019; Uddin, 2020).

Within communities, behavioral determinants of mosquito control need to be investigated and the impact of educational programs on practice should be assessed. Future policies should also encourage eco-friendly methods for vector control, including release of Wolbachia-infected mosquitoes and biological larvicides. Such gaps need to be addressed through increased investment, better training and technical exchanges with other countries if future dengue prevention and control programmed are to be sustainable in Bangladesh.

Table 5: Research Gaps Mapped to Future Studies.

Research Gap	Why It Matters	Proposed Study Design	Data Needed	Feasibility / Potential Partners
Limited long-term dengue surveillance data	Inconsistent case reporting prevents understanding of epidemic cycles and serotype shifts over time	Longitudinal cohort and retrospective surveillance study (2000–2030)	Historical case data, serotype records, hospital admissions	DGHS, WHO-SEARO, IEDCR, Public Health Institutes
Lack of integrated climate–health modeling	Climate variability drives dengue transmission; predictive tools are underdeveloped	Quantitative modeling using climate, vector, and epidemiological variables	Meteorological data, rainfall, humidity, temperature, vector density	Bangladesh Meteorological Dept., BUET, WHO, IPCC-linked researchers
Inadequate socio-behavioral research on prevention practices	Public awareness directly influences mosquito breeding and community control success	Cross-sectional KAP (Knowledge, Attitude, Practice) surveys and ethnographic studies	Household-level survey data, sanitation behaviors, education level	BRAC, ICDDR,B, universities, local NGOs
Limited genomic and serotype evolution studies	Viral mutation patterns affect vaccine development and outbreak severity	Molecular epidemiology and whole-genome sequencing studies	DENV samples, viral genomes, RT-PCR data	DGHS, ICDDR,B, international virology labs
Under-researched rural dengue transmission dynamics	Current research focuses mainly on urban Dhaka; rural spread is under-documented	Spatial and entomological field studies across rural districts	Rural case reports, vector indices, socioeconomic data	Rural health centers, district hospitals, academic institutions
Weak evaluation of vector control interventions	Effectiveness of larviciding, fogging, and community drives remains uncertain	Mixed-method intervention evaluation study	Program coverage data, entomological surveys, cost data	Dhaka City Corporation, MoHFW, WHO, UNICEF
Limited studies on economic burden and cost-effectiveness	Policymakers need economic evidence to allocate health resources efficiently	Cost–benefit and cost-effectiveness analysis	Healthcare expenditure data, income loss estimates, hospitalization costs	Ministry of Finance, WHO, UNDP, health economists
Poor coordination between health and environment sectors	Fragmented governance hinders multi-sectoral dengue control efforts	Policy analysis and institutional capacity assessment	Policy documents, stakeholder interviews, institutional framework	MoHFW, MoEFCC, UN-Habitat, ADB
Low community engagement in prevention programs	Sustainable vector control requires behavioral ownership at community level	Participatory action research and behavioral intervention trials	Community feedback data, behavioral metrics, intervention outcomes	BRAC, Save the Children, local community groups
Limited assessment of vaccine acceptance and readiness	Public perception and policy preparedness for dengue vaccination are unclear	Mixed-method public acceptance and policy readiness survey	Survey responses, demographic and attitudinal data	DGHS, UNICEF, GAVI, academic researchers

Notes: This table aligns with the findings in Section 7 (Research Gaps and Future Directions). It highlights priority areas for multidisciplinary collaboration across health, climate, and social sectors. Each proposed study type directly supports the national dengue control and preparedness goals (2025–2030).

2. Conclusion

This study systematically reviewed the dengue outbreak in Bangladesh during 2000–2024, and provided valuable insights into its epidemiological pattern, geographical distribution, environmental determinants as well as management implications. The results suggest that dengue has evolved from episodic disease to a frequent epidemic of national significance. The initial large outbreak in 2000 was the first public health threat of continuous public health importance with increasing severity during subsequent surges in 2002, 2019 and 2023 showing that the virus's both coverage but also its severity is growing. Dhaka still is the epicenter, contributing to more than half of all cases reported as a result of high population density and poor sanitary condition and conductive breeding sites for Aedes aegypti mosquitoes. The circulation and prevalence of DENV-3 in the past few years has been found to be linked with severe clinical symptoms such as DHF/DSS. Season-based effects including rain, temperature and humidity were the strongest predicting factors of dengue incidence, which peaked in monsoon season followed by post-monsoon. Despite efforts by authorities the disease has proven difficult to control due to patchy surveillance, poor healthcare infrastructure and low public awareness of the dangers. Increasingly frequent and severe dengue outbreaks are a major public health challenge in Bangladesh. The repeated outbreaks have unveiled institutional frailties such as slow detection, inadequate laboratory capacity and lack of healthcare infrastructure. Urban expansion and uncontrolled urban development also contribute to worsening of dengue, which demonstrates the imperative for integrated planning for health and environment in urban setting. Furthermore, the growing co-circulation of several dengue serotypes has implications for antibody-dependent enhancement (ADE) leading to severe secondary infections. Global warming, with erratic and increased rainfall are conditions that also contributes to the epidemiological panorama by enlarging the vector breeding sites as well as extending transmission seasons. These results point on the need of a multisectoral dengue prevention, management and control including public health, environment, and urban planning policies. Improving the vector surveillance, immediate data systems and prevention access to education are key factors to limit the disease impact on health and economy. A consolidated and strengthened national and local policy environment is required in Bangladesh for effective response to the Dengue epidemic. First, we should focus on establishing an integrated digital dengue surveillance system to facilitate real-time reporting and evidence-based decision-making. Secondly, IVM interventions (including environmental improvement/ sanitation, biological control and community-based practices) should replace temporary fogging operations with limited sustainability. Third, increased preparedness for health care by increasing the number of dengue wards and personnel training alongside improved laboratory diagnostics will decrease case fatality rates during outbreak peaks. Fourth, climate-sensitive public health planning should be incurporated into national policies to ensure that as urban infrastructure expands, the risk of mosquito breeding is reduced. Furthermore, a multi-inter-sectoral coordination between the government's organizations, non-governmental and international partners are essentially needed to assure sustained financing and mobilization of communities for dengue prevention. Lastly, there is need for the further development of dengue vaccines, antiviral therapies and local vector ecology as long-term preventive tools in future policy. Through this way Bangladesh can progress to a dengue management system, which will be more sustainable and proactive and help decreasing disease burden and ensuring public health.

3. Author Contributions

S.A.M.: contributed to the conceptualization, methodology, data analysis, and drafting of the manuscript. He also contributed to the review and interpretation of data. S.M.B.U.L.I.: provided guidance on the research methodology, reviewed the manuscript, and contributed to the critical interpretation of the results. A.B.R.: assisted in data collection, contributed to literature review, and helped in the finalization of the manuscript.

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5. Conflicts of Interest

The authors declare that they have no conflicts of interest related to this research.

6. References

Ali, A. S., & Rahman, M. (2022). Predictive modeling of dengue outbreak in Bangladesh using meteorological data. *International Journal of Infectious Diseases Forecasting,* **7**(1), 22–29.

Ali, M. S., & Nasreen, R. (2021). Evaluation of larval indices for dengue risk assessment in Dhaka. *Journal of Vector Ecology,* **46**(2), 176–185.

Alam, H. (2021). Role of NGOs in dengue prevention in Bangladesh. *Community Health Journal,* **7**(3), 67–74.

Alam, S. H. (2019). Dengue control strategies: A public health perspective in Bangladesh. *Bangladesh Medical Journal,* **34**(2), 1–9.

Alonso, P. L., & Halstead, L. (2019). Dengue vaccine development: Progress and future challenges. *Lancet Infectious Diseases,* **18**(7), 714–726.

Banu, H., *et al*. (2011). Effect of temperature and rainfall on dengue transmission dynamics in Bangladesh. *Environmental Health Perspectives,* **119**(12), 1737–1743.

Bindra, N. P. (2021). Lessons learned from dengue outbreak response: Southeast Asia case study. *Lancet Regional Health Asia,* **3**(6), 1–9.

Bhowmik, S. H., & Rahman, P. (2021). Socio-economic burden of dengue on informal workers. *Asian Economic Health Policy Journal,* **5**(4), 211–220.

Brady, J. M., *et al*. (2019). The global expansion of dengue: Epidemiology and drivers. *Trends in Parasites,* **35**(10), 887–898.

Centers for Disease Control and Prevention (CDC). (2021). Technical assistance report on dengue control in Bangladesh. U.S. Department of Health and Human Services.

Chowdhury, M. K., & Islam, F. (2021). Sero-epidemiology of dengue in Bangladesh: A systematic review. *Tropical Biomedicine,* **38**(1), 15–25.

Gani, A. A. (2020). Epidemiological modeling of dengue virus spread in tropical countries. *Mathematical Biosciences,* **330**, 1–12.

Gupta, A. (2019). Emerging infectious diseases and vector adaptation in South Asia. *WHO South-East Asia J. of Public Health,* **8**(3), 211–220.

Halder, S. S., & Akter, R. (2020). Household waste management and dengue vector proliferation: A case study of Dhaka city. *Urban Health Perspectives,* **5**(2), 88–95.

Homyra A, Goni MS, Nafsi NN, and Islam MM. (2025). Knowledge, attitude and practices of people regarding dengue fever and the concept of dengue vaccine in Dhaka, Bangladesh, *Eur. J. Med. Health Sci*., **7**(3), 462-472. https://doi.org/10.34104/ejmhs.025.04620472

Hossain, Z., Rahman, M. M., & Uddin, K. A. (2020). Geographic distribution of dengue cases in Bangladesh: Implications for vector control. *Bangladesh Medical Journal,* **18**(4), 12–18.

Hossain, M. A., Islam, R., & Hossain, M. (2021). Community engagement and behavioral interventions in dengue vector control: Lessons from Bangladesh. *Journal of Environmental and Public Health,* **15**(2), 77–85.

Hossain, M. P., Rahim, Z., & Chowdhury, N. K. (2022). Genetic diversity and mutation analysis of dengue virus strains in Bangladesh. *Virology Journal,* **19**(1), 15–23.

Islam, N. (2021). GIS-based mapping and spatial analysis of dengue risk zones in Bangladesh. *Inter J. of Geospat. Health,* **17**(2), 77–89.

Khan, A. A., & Ferdous, M. J. (2021). Healthcare resource utilization during dengue outbreaks: A hospital-based analysis. *Bangladesh Health Economics Review,* **3**(1), 55–63.

Karim, M. A., & Sultana, S. (2020). Climate variability and vector ecology: Implications for dengue control. *Environmental Research Journal,* **18**(2), 55–63.

Mohammed, R. S. (2021). Impact of climate change on the spread of dengue in urban areas of Bangladesh. *Environmental Health Perspectives,* **128**(5), 1–10.

Mohammad Zakerin Abedin, Laila Jarin, Rubait Hasan, *et al*. (2021): Analysis of the Dengue Infection, Occurrence and Hematological

Profile of Dengue Patients in Dhaka City, *J Microbiol Pathol*., **5**, 115. www.hilarispublisher.com/open-access/analysis-of-the-dengue-infection-occurrence-and-hematological-profile-of-dengue-patients-in-dhaka-city.pdf

Mutsuddy, M. M. O. (2021). Evaluation of surveillance methods for dengue outbreak monitoring. *Global Health Research,* **10**, 35–40.

Nguyen, T. (2020). Global dengue vaccine pipeline: Challenges for implementation. *Vaccine,* **38**(40), 6355–6364.

Paul, S. (2020). Role of mass media in dengue awareness in Bangladesh. *Asian Communication Journal,* **9**(1), 23–31.

Rahman, F. A., & Khan, S. H. (2021). Preparedness of healthcare facilities in managing dengue outbreaks: A national review. *Asian Journal of Public Health Studies,* **7**(1), 65–73.

Rahman, F. A., & Khan, S. H. (2022). Public-private partnership and international collaboration in dengue prevention: The Bangladesh experience. *Global Health Policy Review,* **5**(3), 112–119.

Rahman, M. A., Islam, S., & Haque, M. N. (2020). Socioeconomic impacts of dengue fever among low-income families in Dhaka. *Journal of Health Economics and Development Studies,* **5**(2), 31–38.

Sarkar, N. R. (2020). Hospital management and clinical challenges during dengue epidemics. *Bangladesh Journal of Medical Science,* **18**(2), 114–120.

Shepard, D. S., Undurraga, E. A., & Halasa, Y. A. (2016). Economic impact of dengue illness in the Americas and Asia. *American Journal of Tropical Medicine and Hygiene,* **84**(2), 200–207.

Sharma, N. S. (2019). Vector control strategies in urban areas of Bangladesh: Challenges and opportunities. *Bangladesh Journal of Public Health,* **13**(4), 45–50.

Shazeed-Ul-Karim, (2019). Dengue and recent mosquito-borne viral fever outbreak in Bangladesh: concern, causes and control, *Am. J. Pure Appl. Sci*., **1**(6), 44-48. https://doi.org/10.34104/ajpab.019.01944048

Sultana, M., & Sultana, N. (2022). Molecular epidemiology and serotype dynamics of dengue virus in Bangladesh. *Bangladesh Virology Review,* **8**(2), 34–42.

Uddin MA. (2020). Exploring socio-economic impact of dengue fever in Dhaka city: a statistical modeling approach, *Eur. J. Med. Health Sci*., **2**(6), 125-133. https://doi.org/10.34104/ejmhs.020.01250133

World Bank. (2021). Climate risk profile: Bangladesh 2021. *World Bank Group*.

World Health Organization. (2009). Dengue: Guidelines for diagnosis, treatment, prevention and control. Geneva, Switzerland: WHO.

World Health Organization. (2017). *Global vector control response 2017–2030*. Geneva, Switzerland: WHO.

World Health Organization. (2018). Dengue vaccine: WHO position paper. Geneva, Switzerland: WHO.

World Health Organization. (2022). Regional dengue situation update 2022. WHO-SEARO.

World Health Organization. (2012). Global strategy for dengue prevention and control 2012–2020. Geneva, Switzerland: WHO.

Citation: Mahir SA, Islam SMBUL, and Rashid AB. (2026). A comprehensive review of dengue in Bangladesh: epidemiology, drivers, and control (2000–2024), *Eur. J. Med. Health Sci*., 8(1), 610-624. https://doi.org/10.34104/ejmhs.026.06100624