




# A perspective on the worst ever dengue outbreak 2023 in Bangladesh: What makes this old enemy so deadly, and how can we combat it?

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## Abstract

**Background and Aims:** Bangladesh has been going through outbreaks of dengue fever cases every year since 2000. Yet this year's (2023) episode of dengue fever has crossed every line concerning fatality. Symptoms of the fever range from high fever, headaches, and muscle aches to deadly dengue hemorrhagic fever (DHF). The present review aims to assess the current pathogenicity and associated risk factors of recent dengue outbreaks in Bangladesh.

**Methods:** To perform this review work, we extracted relevant information from published articles available in PubMed, Scopus, and Google Scholar. We used dengue virus, dengue fever, and dengue outbreaks as keywords while searching for information.

**Results:** This Aedes mosquito-transmitted viral fever is more common in Bangladesh because of the tropical nature and immense burden of populations, resulting in convenient conditions for the reproduction of the vector. The rapid genetic transformation of this RNA virus and the resistance of its vector against insecticides have intensified the situation. The number of hospitalized patients has increased, and the case fatality rate has risen to 0.47%. Inadequate mosquito control measures, plenty of vector breeding sites, and a lack of public awareness have worsened the situation. Routine spraying of effective insecticides in high-risk zones, regular inspection of potential mosquito breeding sites, and public awareness campaigns are the keys to limiting the spread of this virus. Also, the availability of detection kits, improved hospital settings, and trained health professionals are mandatory to keep disease fatalities under control.

**Conclusion:** Dengue fever is a preventable disease. The successful development of a competent vaccine is now a prime need for preventing any future upsurge of the disease. Also, we recommend public awareness, vector control activities, and global collaboration to prevent spread.

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## KEYWORDS

communicable diseases, dengue, dengue fever, dengue virus, disease outbreaks, public health

## 1 | BACKGROUND

The mosquito-borne viral virus known as dengue fever has been a significant cause for concern regarding the state of public health in Bangladesh for several years.<sup>1-4</sup> The tropical temperature, monsoon rains, and dense urban populations of the country generate conditions conducive to the expansion of the *Aedes* mosquito, which is the primary vector for the transmission of the dengue virus.<sup>5,6</sup> Infection with any one of the dengue virus's four unique serotypes does not protect against infection with any of the other serotypes.<sup>7</sup> This characteristic has been shown to be a contributor to the cyclical pattern of dengue outbreaks in Bangladesh. When a new serotype becomes prevalent, people exposed to a different serotype become susceptible to infection, increasing the number of infections.<sup>8</sup> The stagnant water typically found in discarded containers, open water storage, and building sites provides the perfect breeding ground for the *Aedes* mosquito.<sup>9</sup> As a direct consequence, the locations in question turn into fertile breeding grounds for mosquitoes, making the virus more easily spread.

The first documented case of dengue fever in Bangladesh was in 1964. Since then, there have been other large outbreaks, the most recent of which occurred in 2000, 2019, and 2022. The outbreak that occurred in 2019 was the worst one ever recorded, with over 100,000 illnesses and 266 fatalities.<sup>10</sup> There has been an uptick in the number of dengue cases in Bangladesh. These dengue outbreaks in 2019 and 2023 have been driven by a confluence of factors. Climate change, which has raised temperatures and rainfall, has made *Aedes* mosquitoes, the main dengue carriers, thrive. Urbanization and informal settlements have increased mosquito breeding places. Vector resistance to standard insecticides complicates dengue control, allowing transmission. Population density and mobility, especially in cities, have helped viruses spread. Vector control resources and public knowledge remain issues.<sup>11,12</sup> COVID-19 focus in 2019 and pandemic-induced disruptions in 2023 hampered dengue monitoring and management, contributing to increased case numbers in 2023.

Dengue is a severe disease that can cause a broad spectrum of symptoms, ranging from a relatively low to life-threatening dengue hemorrhagic fever (DHF). DHF is a condition that puts a person's life in danger and can result in bleeding, shock, and, ultimately, death. If a person has been exposed to more than one type of dengue virus, they have a greater chance of having DHF. This is because the body's immune system can react to the second infection, worsening the severity of the condition. There is currently no cure or treatment specific to dengue. The treatment provides comfort and involves steps to control symptoms such as fever, discomfort, and fluid loss.<sup>13,14</sup> Patients experiencing severe symptoms may require hospitalization to receive blood transfusions and intravenous fluids.

## 2 | THE FEATURE OF ONGOING DENGUE OUTBREAK IN BANGLADESH

The ongoing dengue epidemic in Bangladesh is characterized by unique characteristics that amplify its impact. A crucial aspect is the rapid mutation of dengue viruses, which are RNA-based entities that readily transform, posing obstacles to developing vaccines and treatments.<sup>14</sup> New dengue serotypes, previously unobserved in Bangladesh, have emerged, heightening susceptibility to infection. This significant shift occurred in 2019, when DENV3 replaced DENV2 as the predominant serotype. However, the recent outbreak reveals DENV2 as the primary circulating serotype, potentially leading to more severe dengue cases due to heterologous serotype reinfection. In June 2023, DENV2 (51.5%) and DENV3 (43.9%) were the prominent serotypes. Another study reported that the predominance of DENV2 exposes over 75% of dengue patients.<sup>15,16</sup> Dengue's vector mosquitoes, *Aedes aegypti*, are becoming insecticide resistant, hindering efforts to control the population.<sup>17</sup> The dengue viruses exhibit distinctive characteristics that contribute to the epidemic, such as rapid mutability, which enables immune response evasion; recombination, in which genetic material exchange generates hybrid viruses that pose a challenge to treatment strategies; and the capacity to resist vaccines and therapies, which threatens long-term efficacy.<sup>18</sup> As this pandemic persists, it is essential to comprehend these complex viral characteristics and contextual factors to devise effective control strategies to address this urgent public health problem.

This outbreak occurs amid climate change, which exacerbates the country's vulnerability to its impacts, such as increased flooding and modified rainfall patterns.<sup>19</sup> These environmental changes have played a significant role in the progression of the pandemic, creating optimal conditions for mosquito proliferation. Temperature and humidity increases have created a favorable breeding environment for mosquitoes, and increased precipitation has resulted in an abundance of standing water sites-optimal mosquito breeding grounds.<sup>18</sup> The changing landscape, characterized by urban expansion and informal settlements, has exacerbated the problem by providing more reproductive habitats.<sup>19</sup> The increasing resistance of mosquitoes to conventional insecticides, a resistance that has grown over time, further complicates control efforts. Within this complex interplay of environmental factors and their effects, the dengue outbreak exemplifies the intersection of climate change and public health. It necessitates the development of adaptive strategies that address both vectors of concern.

Unlike previous epidemics, which primarily affected children, the current outbreak affects all age categories, including adults and older people.<sup>20</sup> These changes highlight the evolving nature of the epidemic and raises concerns about its underlying dynamics. A convergence of human factors contributes to the persistence of the

outbreak. Among them is the inadequacy of vector control measures resulting from difficulties in their implementation. The government faces problems such as inadequate funding, a lack of trained personnel, and the emergence of insecticide-resistant mosquitoes.<sup>21</sup> These obstacles impede the efficient containment of the disease's vector, extending its reach.

Lack of public awareness about dengue is an additional crucial factor.<sup>22</sup> A substantial fraction of the Bangladeshi population continues to be unaware of the disease's dangers and preventative measures, posing a significant obstacle to outbreak control.<sup>23</sup> Patients frequently present at advanced stages, necessitating immediate intensive care unit (ICU) admission. The ICU admissions predominantly involve individuals with multiorgan dysfunction, characterized by inadequate oxygen saturation and unrecordable blood pressure. A notable challenge is the altered presentation of dengue symptoms, leading to delayed diagnosis. Patients often fail to recognize early signs, resulting in delayed hospitalization. These late-stage dengue cases exhibit a spectrum of atypical symptoms, including diarrhea, vomiting, peripheral edema, and neurological manifestations. Traditional indicators like high fever and rash have become less reliable diagnostic markers.<sup>24</sup> This confluence of factors highlights the complexity of the ongoing pandemic, necessitating multifaceted measures to mitigate its effects.

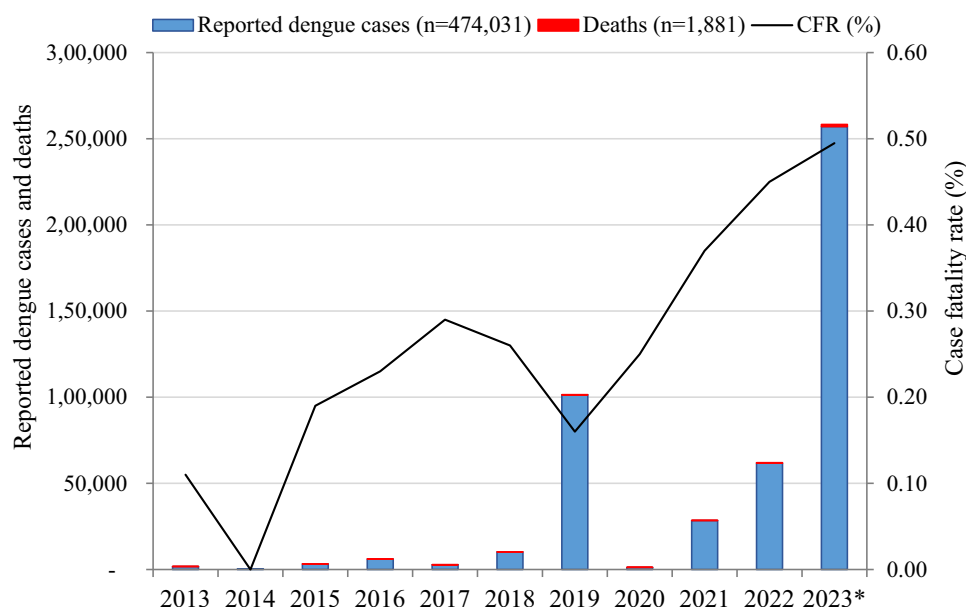
### 3 | IMPACT OF DENGUE OUTBREAK 2023 IN BANGLADESH

The current dengue outbreak in Bangladesh has resulted in severe effects. As of October, 23, 2023, hospitalized dengue cases reached an alarming figure of 257,060, accompanied by 1272 fatalities with case fatality rate 0.5% which the highest in the past decade

(Figure 1).<sup>10</sup> This epidemic is one of the most significant occurrences of dengue cases within a single year in the nation's history. The range of symptoms observed reflects the unpredictable behavior of the virus, encompassing moderate presentations like fever, headache, and muscle discomfort, as well as severe manifestations like DHF, characterized by a combination of high fever, hemorrhage, and shock that pose a significant risk to the individual's life.<sup>25</sup>

The 2023 dengue outbreak in Bangladesh showed regional variations, with urban and rural areas facing different challenges. Due to fast urbanization and a high population density and mosquito breeding places, dengue incidence has increased in Dhaka and Chittagong. As of October 23, 2023, Dhaka had 779 dengue-related deaths, a 0.8% case-fatality rate. Rural areas, once sheltered by lower population density, have also been affected. They struggle with public awareness, healthcare access, and vector control. Outside Dhaka, 493 deaths were reported, a 0.3% case-fatality rate, up from prior years. Due to delayed diagnosis and low rural awareness, experts believe the true rates are greater.<sup>10</sup>

The pathophysiological mechanisms of the viral onslaught are orchestrated in a complex manner, whereby the dengue virus infiltrates and disrupts white blood cells, leading to a dangerous manifestation of bleeding and shock.<sup>26</sup> Amid this situation, the virus strategically utilizes its quadruple serotype attack, a distinctive coordination that increases the probability of severe illness, especially among individuals with prior exposure to dengue.<sup>27</sup> Heterologous serotype reinfection heightened the risk of severe dengue in the event of a second infection with a different serotype. Infection with one serotype provides long-term immunity to the homologous serotype but not to the other serotypes; sequential infections with a different serotype put people at greater risk for severe dengue.<sup>15</sup> In light of the current pandemic, the healthcare system faces significant challenges in managing the increasing



**FIGURE 1** Number of reported dengue cases and deaths from 2013 to 2023, Bangladesh. \*As of October 23, 2023.

number of individuals requiring medical attention. Consequently, hospitalization has become an unavoidable need, with a particular emphasis on attending to the most severe cases.

The COVID-19 pandemic has significantly affected healthcare systems and dengue fever dynamics. While the direct link between COVID-19 and dengue outbreaks isn't definitive, several key factors must be considered. COVID-19 has been a drain on hospital resources, delaying dengue diagnosis and treatment. Human behavior changes like lockdowns and travel restrictions have slowed and concentrated dengue transmission. The pandemic has also shifted public health resources and *Aedes* mosquito breeding places, which may hinder dengue control. This interaction highlights the necessity for adaptable infectious disease management.

While comparatively low from a larger perspective, the mortality rate presents a significant concern in severe cases, with the ongoing outbreak demonstrating a case fatality rate of 0.5%.<sup>10</sup> The aforementioned figures serve as a poignant reminder that the prevalence of severe dengue significantly increases to approximately 10%, highlighting the pressing and intricate nature of the current problem. In addition to its therapeutic implications, the outbreak's impact extends throughout the nation's various domains, including its economy, society, and politics.<sup>28</sup> The economic ramifications are evident since substantial sums of money are absorbed by healthcare expenditures and reductions in productivity. The disruption of life and the increase in fear have led to a decline in social cohesion, while the political landscape is experiencing instability due to the high expectations and criticisms placed upon it. This has prompted the government to take measures to reduce the impact of the outbreak and has sparked public scrutiny regarding its handling of the situation.<sup>11</sup>

In light of the prevailing dengue outbreak, the government of Bangladesh has undertaken a comprehensive response by implementing strategic policies. To mitigate the spread of the virus, there has been an increased focus on implementing vector control measures, which involve intensified insecticide spraying and precise eradication of mosquito breeding sites. Simultaneously, an extensive public awareness campaign has been initiated to educate the general population about the intricacies of dengue and the implementation of productive preventive measures.<sup>29,30</sup> Moreover, implementing an enhanced healthcare infrastructure has emerged as a fundamental aspect of the policy response, as seen by the proliferation of medical facilities and clinics specifically designed to cater to the needs of those afflicted with dengue. The healthcare authorities in Bangladesh have ensured the availability and affordability of dengue testing across the countries. The government's implementation of this comprehensive strategy highlights the pressing need to control the outbreak and demonstrates the nation's dedication to protecting public health. Bangladesh is grappling with an unyielding foe, evidently challenging the nation's resilience and healthcare system.<sup>30</sup> The imperative to effectively manage and proactively mitigate future occurrences of dengue outbreaks has become a prominent concern, given the multifaceted consequences it poses to the nation's healthcare system, socioeconomic landscape, and governance. Within this crucible, the knowledge acquired and measures implemented will shape the future readiness of Bangladesh to fight intricate epidemiological enemies in the forthcoming years.

## 4 | ACTIONABLE ITEMS TO COMBAT OUTBREAK AND LONG-TERM MOSQUITO PREVENTION

In response to the ongoing dengue outbreak that has cast a shadow over Bangladesh, a strategic roadmap of actionable items arises as a beacon of hope to combat the current crisis and erect defenses against future outbreaks. This multifaceted approach combines immediate responses with long-term preventive measures, demonstrating the nation's dedication to protecting public health. To effectively combat dengue, intensifying vector control activities is essential. This includes intensified insecticide spraying, particularly in high-risk areas, and the relentless pursuit of eliminating mosquito reproductive grounds. As a proactive line of defense, institutionalize routine inspections of water storage containers, gutters, and other potential reproductive sites. In the struggle against dengue, knowledge is a powerful tool. The government should continue and expand public education campaigns regarding dengue's symptoms, transmission, and preventative measures. Utilizing the media, community engagement, and educational institutions, this initiative equips individuals to be vigilant and take preventive measures. Strengthening the healthcare system's ability to manage dengue cases is essential. Expanding the number of hospitals and clinics outfitted to treat dengue patients; the existing infrastructure can relieve its burden. This should be accompanied by training healthcare professionals in diagnosing and treating dengue so that they can provide effective, expeditious care. The major route of transmission of dengue virus occurs through mosquito vectors. However, the virus can be spread through blood/body fluid transfusion, organ transplant, or through a needle stick injury.<sup>31,32</sup> Therefore, healthcare professionals should take additional precautions for blood transfusion during the dengue outbreak. Moreover, the single-dose tetravalent dengue vaccine (TV005) showed well tolerability and immunogenicity for all four serotypes in an all-age population in dengue-endemic Dhaka, Bangladesh.<sup>33</sup> Now, the healthcare authorities can pursue the next steps of research for the successful development of dengue vaccines for the citizens of Bangladesh.

A surveillance system that rapidly detects dengue cases is crucial. Improved data collection, analysis, and reporting mechanisms facilitate the mapping of outbreak patterns, thereby facilitating the deployment of rapid responses. This early warning system is a crucial component of strategies for outbreak containment. In rural areas, distributing dengue detection devices to health centers and training health facilitators would be advantageous. Since clothing functions as a preventative measure, schoolchildren should be given special attention by improving their uniforms. Information about dengue phases, bed nets and mosquito repellents, and the media could disseminate the donning of light-colored, loose-fitting, long-sleeved, and breathable clothing. Investing in research to comprehend local genotypes of dengue and their interactions can inform the development of tailored interventions. Bangladesh can contribute to vaccine development efforts by collaborating with research institutions, thereby reducing the potential impact of future outbreaks. Long-term prevention requires an interdisciplinary approach.

Prioritize in urban planning waste management and drainage systems that prevent mosquito reproduction. Green spaces and sustainable urban design can reduce mosquito habitats and improve overall quality of life. Dengue knows no boundaries. Collaboration with neighboring nations and international organizations can facilitate the exchange of information, the sharing of resources, and the coordination of responses. The nation's resources against dengue can be strengthened by emulating the most influential global practices. Empowering communities to assume responsibility for dengue prevention promotes lasting change. By involving local leaders, institutions, and community groups in awareness campaigns, clean-up efforts, and reporting mechanisms, a collective defense against the virus can be established. As climate change influences the distribution and behavior of mosquitoes, it is essential to incorporate climate adaptation strategies into dengue prevention measures. Future epidemics can be prevented by predicting and mitigating the effects of climate change. The mosquito's spread can be hindered by enforcing regulations that ensure water storage practices, refuse disposal, and construction adhere to dengue-prevention guidelines. Regular inspections and penalties for infractions serve as an incentive for compliance. The accumulation of these actionable items results in a comprehensive strategy that halts the current dengue outbreak and forges a robust defense against future incursions. Bangladesh's dedication to improving public health, willingness to adapt and learn, and pursuit of collaborative solutions demonstrate its resolve to wrest the initiative from dengue and pave the way for a future of reduced vulnerability and increased preparedness.

Achieving maximum benefit in dengue outbreak mitigation requires a strategic approach, focusing on multi-stakeholder collaboration, innovative research, community engagement, sustainable urban planning, climate adaptation strategies, and international collaboration. To combat recurring dengue outbreaks in Bangladesh effectively, stakeholders, including government, healthcare professionals, researchers, and community leaders, must work together through multidisciplinary task forces. Prioritizing research and innovation can lead to better treatments and vector control methods. Engaging local communities can spread awareness, and sustainable urban planning can reduce mosquito breeding sites. Considering climate change's impact on transmission and fostering international collaboration are vital steps in addressing this multifaceted challenge.

## 5 | CONCLUSION

The ongoing dengue outbreak in 2023 has inflicted profound challenges upon Bangladesh, underscoring the urgent need for a multifaceted approach to combat the current crisis and fortify defenses against future outbreaks. The outbreak's unique characteristics, including rapid virus mutation, environmental shifts due to climate change, and evolving infection patterns across age groups, demand tailored strategies. To address these challenges, this multifaceted approach can be organized into a step-by-step response plan comprising immediate and long-term actions. Immediate interventions, including escalated vector control and

robust public awareness campaigns, are pivotal in curbing transmission. Strengthening healthcare systems and establishing agile surveillance systems ensure efficient outbreak management. In the long term, research collaboration for vaccine development and climate adaptation strategies are essential. Urban planning, community engagement, and international collaboration contribute to holistic dengue prevention. By implementing these steps, Bangladesh can effectively combat the ongoing outbreak while fortifying itself against future dengue threats, prioritizing proactive, well-coordinated, and evidence-based strategies. This approach aims to reduce vulnerability and enhance public health readiness, underscoring Bangladesh's determination to conquer the challenges posed by dengue outbreaks.

## AUTHOR CONTRIBUTIONS

**Rapty Sarker:** Conceptualization; data curation; writing—original draft. **A. S. M. Roknuzzaman:** Conceptualization; data curation; writing—original draft. **Faisal Abdullah Emon:** Validation; visualization. **Syed Masudur Rahman Dewan:** Writing—review and editing. **Md. Jamal Hossain:** Writing—review and editing. **Md. Rabiul Islam:** Conceptualization; supervision; visualization; writing—review and editing.

## CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

## TRANSPARENCY DECLARATION

The lead author Md. Rabiul Islam affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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## REFERENCES

1. Shayla TA, Paul M, Sayma NJ, Suhee FI, Islam MR. The dengue prevalence and mortality rate surpass COVID-19 in Bangladesh: possible strategies to fight against a Double-Punch attack. *Clin Pathol.* 2023;16:2632010X231181954. doi:10.1177/2632010X231181954
2. Das R, Emon MPZ, Shanu SA, Akter D, Islam MR. A haemophilic dengue patient with pleural effusion and earache. *Cureus.* 2020;12(8):e9572. doi:10.7759/cureus.9572
3. Rahman FI, Ether SA, Islam MR. Upsurge of dengue prevalence during the third wave of COVID-19 pandemic in Bangladesh: pouring gasoline to fire. *Clin Pathol.* 2022;15:2632010X221076068. doi:10.1177/2632010X221076068



4. Hossain MJ, Soma MA, Islam MR, Emran TB. Urgent call for actionable measures to fight the current co-epidemic of dengue burden during the SARS-CoV-2 delta variant era in South-Asia. *Eth Med Pub Health*. 2021;19:100726. doi:10.1016/j.jemep.2021.100726
5. Sharmin S, Viennet E, Glass K, Harley D. The emergence of dengue in Bangladesh: epidemiology, challenges and future disease risk. *Trans R Soc Trop Med Hyg*. 2015;109(10):619-627. doi:10.1093/trstmh/trv067
6. Salje H, Paul KK, Paul R, et al. Nationally-representative serostudy of dengue in Bangladesh allows generalizable disease burden estimates. *eLife*. 2019;8:e42869. doi:10.7554/eLife.42869
7. Roy SK, Bhattacharjee S. Dengue virus: epidemiology, biology, and disease aetiology. *Can J Microbiol*. 2021;67(10):687-702. doi:10.1139/cjm-2020-0572
8. Brito da Cruz AMC, Rodrigues HS. Personal protective strategies for dengue disease: simulations in two coexisting virus serotypes scenarios. *Math Comput Simul*. 2021;188:254-267. doi:10.1016/j.matcom.2021.04.002
9. Dalpadado R, Amarasinghe D, Gunathilaka N. Water quality characteristics of breeding habitats in relation to the density of *Aedes aegypti* and *Aedes albopictus* in domestic settings in gampaha district of Sri Lanka. *Acta Trop*. 2022;229:106339. doi:10.1016/j.actatropica.2022.106339
10. Directorate General of Health Services (DGHS). *Dengue Press Release*. 2023. Accessed August 15, 2023. <https://old.dghs.gov.bd/index.php/bd/home/5200-daily-dengue-status-report>
11. Kayesh MEH, Khalil I, Kohara M, Tsukiyama-Kohara K. Increasing dengue burden and severe dengue risk in Bangladesh: an overview. *Tropical Med Infect Dis*. 2023;8(1):32. doi:10.3390/tropicalmed8010032
12. Bhowmik KK, Ferdous J, Baral PK, Islam MS. Recent outbreak of dengue in Bangladesh: a threat to public health. *Health Sci Rep*. 2023;6(4):e1210. doi:10.1002/hsr2.1210
13. Htun TP, Xiong Z, Pang J. Clinical signs and symptoms associated with WHO severe dengue classification: a systematic review and meta-analysis. *Emerg Microbes Infect*. 2021;10(1):1116-1128. doi:10.1080/22221751.2021.1935327
14. Ng WC, Kwek SS, Sun B, et al. A fast-growing dengue virus mutant reveals a dual role of STING in response to infection. *Open Biol*. 2022;12(12):220227. doi:10.1098/rsob.220227
15. World Health Organization. *Dengue-Bangladesh*. August 11 2023. Accessed October 24, 2023. <https://www.who.int/emergencies/disease-outbreak-news/item/2023-DON481#:~:text=Since%202019%2C%20when%20the%20largest,has%20become%20the%20predominant%20serotype>.
16. The Business Standard. Dengue strain shift: Den-2 takes centre stage, causing complications. 2023. <https://www.tbsnews.net/bangladesh/health/dengue-strain-shift-den-2-takes-centre-stage-causing-complications-687674>
17. Erb SM, Butrapet S, Roehrig JT, Huang CYH, Blair CD. Genetic adaptation by dengue virus serotype 2 to enhance infection of *Aedes aegypti* mosquito midguts. *Viruses*. 2022;14(7):1569. doi:10.3390/v14071569
18. Qin L, Evans DH. Genome scale patterns of recombination between coinfecting vaccinia viruses. *J Virol*. 2014;88(10):5277-5286. doi:10.1128/JVI.00022-14
19. Banu S, Hu W, Guo Y, Hurst C, Tong S. Projecting the impact of climate change on dengue transmission in Dhaka, Bangladesh. *Environ Int*. 2014;63:137-142. doi:10.1016/j.envint.2013.11.002
20. Ferede G, Tiruneh M, Abate E, et al. Distribution and larval breeding habitats of *Aedes* mosquito species in residential areas of northwest Ethiopia. *Epidemiol Health*. 2018;40:e2018015. doi:10.4178/epih.e2018015
21. Mamun MA, Misti JM, Griffiths MD, Gozal D. The dengue epidemic in Bangladesh: risk factors and actionable items. *The Lancet*. 2019;394(10215):2149-2150. doi:10.1016/S0140-6736(19)32524-3
22. Spiegel J, Bennett S, Hattersley L, et al. Barriers and bridges to prevention and control of dengue: the need for a social-ecological approach. *EcoHealth*. 2005;2(4):273-290. doi:10.1007/s10393-005-8388-x
23. Rahman MS, Karamelic-Muratovic A, Baghbanzadeh M, et al. Climate change and dengue fever knowledge, attitudes and practices in Bangladesh: a social media-based cross-sectional survey. *Trans R Soc Trop Med Hyg*. 2021;115(1):85-93. doi:10.1093/trstmh/traa093
24. Rahman KN. Why is the dengue death rate worse this year? *bdnews24.com*. 2023. Accessed October 24, 2023. <https://bdnews24.com/bangladesh/ezgjiaow3t>.
25. World Health Organization. *Dengue and Severe Dengue*. March 17, 2023. Accessed August 8, 2023 <https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue>.
26. Chuansumrit A, Tangnaratchakit K. Pathophysiology and management of dengue hemorrhagic fever. *Transfusion Alternatives in Transfusion Medicine*. 2006;8:3-11. doi:10.1111/j.1778-428x.2006.00025.x
27. Roy MG, Uddin K, Islam D, Singh A, Islam MM. All four dengue virus serotypes co-circulate in concurrent dengue infections in a single dengue session in Chittagong, Bangladesh. *Bioresea Commun*. 2021;8(1):1042-1048. doi:10.3329/brc.v8i1.57042
28. BDRCS situation update #01: Dengue in Bangladesh. ReliefWeb. July 20, 2023. Accessed August 13, 2023. <https://reliefweb.int/report/bangladesh/bdrcs-situation-update-01-dengue-bangladesh-17-july-2023>.
29. Bangladesh Issues Dengue Prevention Guidelines for Primary Schools. *bdnews24.com*. 2023. Accessed August 13, 2023. <https://bdnews24.com/health/6lm5mg1paa>.
30. ReliefWeb. Disease outbreak news: Dengue—Bangladesh. August 11, 2023. Accessed August 13, 2023. <https://reliefweb.int/report/bangladesh/disease-outbreak-news-dengue-bangladesh-11-august-2023>
31. Teo D, Ng LC, Lam S. Is dengue a threat to the blood supply? *Transfus Med*. 2009;19(2):66-77. doi:10.1111/j.1365-3148.2009.00916.x
32. Urmi TJ, Mosharrafa RA, Hossain MJ, Rahman MS, Kadir MF, Islam MR. Frequent outbreaks of dengue fever in South Asian countries—A correspondence analyzing causative factors and ways to avert. *Health Sci Reps*. 2023;6(10):e1598. doi:10.1002/hsr2.1598
33. Walsh MR, Alam MS, Pierce KK, et al. Safety and durable immunogenicity of the TV005 tetravalent dengue vaccine, across serotypes and age groups, in dengue-endemic Bangladesh: a randomised, controlled trial. *Lancet Infect Dis*. 2023;S1473-3099(23):00520-0. doi:10.1016/S1473-3099(23)00520-0

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