

# Recent Dengue Infection in Bangladesh: A Seasonal Endemic Progressing to Year-long Serious Health Concern

Sheikh Mohammad Fazle Akbar<sup>1</sup>, Sakirul Khan<sup>2</sup>, Musarrat Mahtab<sup>3</sup>, Mamun Al Mahtab<sup>4</sup>, Takaaki Yahiro<sup>5</sup>, Shohael Mahmud Arafat<sup>6</sup>, Mohammad Abdus Sattar Sarker<sup>7</sup>, Provat Kumar Podder<sup>8</sup>, Mohammad Shawkat Hossain<sup>9</sup>, Faiz Ahmad Khandokar<sup>10</sup>, Mohammad Rashedul Hassan<sup>11</sup>, Md Abdur Rahim<sup>12</sup>, Muhammad Ali Ashraf<sup>13</sup>, Rajib Saha Rony<sup>14</sup>, Akira Nishizono<sup>15</sup>

Received on: 02 October 2023; Accepted on: 04 November 2023; Published on: 22 December 2023

## ABSTRACT

Dengue represents one of the most dangerous mosquito-borne viral diseases. Although the disease has been prevalent around the globe over the centuries, recent outbreaks of dengue have devastated the healthcare delivery system of many countries. Being a global infection, dengue virus (DENV) is endemically present mainly in Latin America and Caribbean countries as well as countries in South Asia. The recent outbreak of DENV infection has indicated an exceptional outbreak of DENV in some countries in South Asia. There has been a serious endemic of DENV during 2019. After a heterogeneous pause, another severe outbreak of DENV was reported in some Asian countries in 2023. Among the Asian countries, Bangladesh has reported an acute upsurge of DENV infection in 2023 with record numbers of fatalities. However, this pattern of DENV has not been detected in neighbors of Bangladesh, such as India or other countries in Southeast Asia. This provides an emergent task of dissecting the present DENV infection in Bangladesh from different angles to get insights for future containment of the DENV infection, not only in Bangladesh but also in other DENV endemic areas or DENV-native areas.

**Keywords:** Bangladesh, Changing epidemiology, Dengue, Global emergency, Year-long endemic.

*Euroasian Journal of Hepato-Gastroenterology* (2023): 10.5005/jp-journals-10018-1408

## INTRODUCTION

Dengue is an arthropod-borne infectious disease of diverse nature and caused by dengue virus (DENV) infection. DENV, an arbovirus transmitted by mosquitoes, has become a significant threat in the global context. The virus is endowed with a unique property of transmission between arthropod vectors and vertebrate hosts.<sup>1,2</sup> As of today, five human epidemic arboviruses have emerged in the world, and DENV is one of the most important of these viruses on the basis of its infectivity and pathogenesis.<sup>3,4</sup> There is a sustained increased incidence of DENV infection around the globe, and it is estimated that DENV infection has increased 30-fold in the last 50 years. Thus, about 50% of the world population, spreading over 100 countries, is at risk of acquisition of DENV.<sup>5</sup> Although most of the DENV infections have been reported from the Latin America and Caribbean region, Western Pacific countries, and South Asia regions,<sup>6</sup> considerable numbers of DENV infections have also been reported from North America, Europe, and African regions as well.<sup>7-9</sup> Dengue virus infection may induce a global public health problem in the near future, and it is essential to dissect the nature and features of DENV in a scientific manner.

Brathwaite and co-workers have segmented the history of DENV in Latin America and the Caribbean, and they commented on the failure of the mosquito eradication program, as well as the increased dispersion of *Ae. aegypti* and dengue virus circulation (2000–2010) resulted in a marked increase in DENV infection in these countries.<sup>10</sup> Since its re-emergence in Latin America, dengue has spread dramatically throughout the region. The number of dengue cases has risen from 1,033,417 in the 1980s to 2,725,405 in the 1990s, and 4,759,007 between 2000 and 2007.<sup>11-14</sup> However, the reported cases represent only the peak of the iceberg, as most DENV infections pass an uneventful and asymptomatic phase.

<sup>1</sup>Department of Gastroenterology and Metabology, Ehime University Graduate School of Medicine; Research Center for Global and Local Infectious Diseases, Faculty of Medicine, Oita University, Oita, Japan; Miyakawa Memorial Research Foundation, Tokyo, Japan

<sup>2,15</sup>Research Center for Global and Local Infectious Diseases; Department of Microbiology, Faculty of Medicine, Oita University, Oita, Japan

<sup>3</sup>Department of Biochemistry and Biotechnology, North South University, Dhaka, Bangladesh

<sup>4</sup>Interventional Hepatology Division, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

<sup>5</sup>Research Center for Global and Local Infectious Diseases; Department of Microbiology; Department of Advanced Medical Sciences, Faculty of Medicine, Oita University, Oita, Japan

<sup>6</sup>Department of Internal Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

<sup>7</sup>Department of Medicine, Sir Salimullah Medical College, Dhaka, Bangladesh

<sup>8,9,14</sup>Department of Hepatology, Sir Salimullah Medical College, Dhaka, Bangladesh

<sup>10</sup>Department of Hepatology, Shaheed Suhrawardi Medical College, Dhaka, Bangladesh

<sup>11</sup>Department of Medicine, Shaheed Suhrawardi Medical College, Dhaka, Bangladesh

<sup>12</sup>Department of Hepatology, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

<sup>13</sup>Acute Medicine Unit, Sir Salimullah Medical, College Mitford Hospital, Dhaka, Bangladesh

**Corresponding Author:** Sheikh Mohammad Fazle Akbar, Department of Gastroenterology and Metabology, Ehime University Graduate School of Medicine; Research Center for Global and Local Infectious

A similar picture is also prevailing in dengue cases in Southeast Asia.<sup>15–18</sup> Although the reported cases of dengue in Asian countries may be a fraction of the actual incidence of DENV infection due to multiple reasons, the majority of dengue cases may have been reported by five countries in Asia (Table 1). However, the real implication of DENV could not be reported from some countries due to the nonavailability of official data from those countries. Considerable levels of heterogeneity are notable regarding reported cases of dengue among these countries on a year-by-year basis. However, the incidence of dengue cases has been maintained within a range of 2–4 times during the last 5 years (2019–2023). The number of dengue cases in dengue-endemic countries of Southeast Asia (The Philippines, India, Malaysia, and Vietnam) has reported fewer dengue cases in 2023 compared with the incidence during the last notable endemic of 2019. After 2019, The Philippines, India, and Vietnam said an upsurge in dengue incidence in 2022. However, in 2023, the number of dengue cases has not surpassed the average number of cases during 2018–2022.

However, to our surprise, there is an unusual surge of reported dengue cases in Bangladesh, a country in Southeast Asia with a population of about 164 million in 2023. Although India surrounds Bangladesh on almost all sides, the incidence and mortality due to DENV are not notable in India in 2023. In this review, the authors aim to provide information about the grave situation of the upsurge of dengue in Bangladesh and the related characteristic features. Due to the upsurge of DENV in Bangladesh, a compilation has been initiated with data up to September 2023 (within the peak of the endemic) and before the final status is known after December 2023.

## DENGUE OUTBREAKS: DENGUE IN GLOBAL PERSPECTIVES

### Recent Significant Outbreaks of Dengue in Latin America and South Asia

It is well-known that DENV infection is endemic in Latin America<sup>10–14</sup> and Southeast Asian countries.<sup>15–18</sup> Although both of these regions are densely populated, and different countries are placed in close proximity to each other, the incidences of dengue in these countries are highly heterogeneous. It is also to be mentioned that the climate and geophysical conditions are mostly comparable among these countries. Thus, the factors that determine the heterogenous status of DENV infection are mostly unknown and unexplored. In this situation, there is a need to analyze more about the incidence of dengue in these countries to develop strategies for containment of dengue.

### Heterogeneous Incidence and Mortality due to Dengue in Latin America

In order to develop proper insights into dengue endemicity, we checked the incidence and fatality of five countries of these two regions that reported the most dengue cases in the last 5 years, including this year (2023). The choice of countries may have limitations of data availability as data regarding incidence and fatality could not be retrieved from some countries due to improper availability of data. The countries of Latin America analyzed about DENV infection and mortality are Brazil, Mexico, Bolivia, Peru, and Nicaragua. On the other hand, the countries of South Asia selected for this analysis are Bangladesh, the Philippines, India, Malaysia, and Vietnam. As shown in Table 1, the incidence, deaths, and case fatality rate (CFR) have been documented for these countries for 5 consecutive years, including 2023. The reported dengue cases have shown considerable heterogeneity in Brazil during these 5 years

Diseases, Faculty of Medicine, Oita University, Oita, Japan; Miyakawa Memorial Research Foundation, Tokyo, Japan, Phone: +81 9099790098, e-mail: sheikhmohammadfazle@gmail.com

**How to cite this article:** Akbar SMF, Khan S, Mahtab M, *et al.* Recent Dengue Infection in Bangladesh: A Seasonal Endemic Progressing to Year-long Serious Health Concern. *Euroasian J Hepato-Gastroenterol* 2023;13(2):145–151.

**Source of support:** This work is partly supported by grants from the Research Center for Global and Local Infectious Diseases (RCGLID), Oita University (No. 2022B04).

**Conflict of interest:** Dr Sheikh Mohammad Fazle Akbar, Dr Mamun Al Mahtab, Dr Faiz Ahmad Khandokar and Dr Md Abdur Rahim are associated as the Editorial Board Members of this journal and this manuscript was subjected to this journal's standard review procedures, with this peer review handled independently of these Editorial Board Members and their research group.

(975,474 in 2021 and 2,569,746 in 2023, almost 2.5 times). However, the CFR remains almost static (0.03–0.04%). The numbers of dengue cases showed marked variations in Mexico and Bolivia, and the CFR showed similar patterns. However, the incidence of dengue is on an increasing trend in Peru with a massive increase in total numbers of deaths, although CFR is mostly comparable among different years of observation. There has been an upsurge of dengue in Nicaragua in 2019, and then a significant outbreak is yet to be surfaced. The CFR is extremely low or nil in this country. In summary, it seems that although dengue is endemic in Latin American countries, the numbers of deaths and CFR have mostly been contained in some countries, whereas there should be more efforts to control the rising incidence and mortality from dengue.

### Dengue in South Asia

Table 1 provides a bird's eye view regarding the reported dengue cases and dengue-related mortality in five Asian countries. Bangladesh and The Philippines are at the top of the list of incidence and fatality due to dengue among South Asian countries. There was an upsurge in dengue cases in the Philippines in 2019. This upsurge of dengue cases in 2019 was noted in all five countries, as shown in Table 1. However, after some decline in dengue cases in 2020 and 2021, another upsurge was seen in 2022. In 2023, the number of cases of dengue is almost 50% of the reported cases in 2022, although the cases may increase during the next few months of 2023.

Malaysia has reported considerable numbers of dengue cases during the last 5 years, with a reduction of incidence in 2021, and this may be due to the emergence of COVID-19. The case fatality rate of dengue in Malaysia has been switching between 0.08 and 0.14%. Although the numbers of reported dengue patients are considerably higher in Vietnam, the CFR is extremely low (0.01–0.04). The dengue epidemiology in India exhibits a different type. The country is close to Bangladesh and harbors about 1.4 billion people (around eight times the population of Bangladesh). However, the incidence of dengue is not so high in India. Dengue-related deaths are also not so pronounced in India. In 2023 (as of September 30), India reported 94,198 cases of dengue, with a death tally of 421.

However, there was a big jump in dengue outbreaks in 2023 in Bangladesh, and the upsurge trend is continuing (as of September 30, 2023). This will be described in more detail in a subsequent chapter of this article.

**Table 1:** Dengue incidences in major endemic countries of Latin America and Southeast Asia<sup>#</sup>

Region	Country	Year	Cases	Deaths	Fatality ratio (%)
Latin America	Brazil	2019	2,248,570	840	0.04
		2020	1,467,142	554	0.04
		2021	975,474	239	0.03
		2022	2,363,490	991	0.04
		2023	2,569,746	912	0.04
	Mexico	2019	268,458	421	0.16
		2020	120,639	79	0.07
		2021	36,742	39	0.11
		2022	59,918	53	0.09
		2023	115,219	30	0.03
	Bolivia	2019	19,987	30	0.15
		2020	111,347	41	0.04
		2021	8,947	2	0.02
		2022	16,544	10	0.06
		2023	137,110	79	0.06
	Peru	2019	17,143	37	0.22
		2020	56,394	88	0.16
		2021	49,274	39	0.08
		2022	72,851	84	0.12
		2023	250,383	419	0.17
	Nicaragua	2019	186,173	30	0.02
		2020	53,953	1	0.00
		2021	36,741	0	0.00
2022		97,541	0	0.00	
2023		97,903	1	0.00	
Southeast Asia	Bangladesh	2019	101,354	164	0.16
		2020	1,405	7	0.50
		2021	28,429	105	0.37
		2022	62,382	281	0.45
		2023	203,406	989	0.49
	Philippines	2019	437,563	1,689	0.39
		2020	90,135	324	0.36
		2021	79,592	286	0.36
		2022	226,492	737	0.33
		2023	111,813	421	0.37
	India	2019	157,315	166	0.11
		2020	44,585	56	0.13
		2021	193,245	346	0.18
		2022	233,251	303	0.13
		2023	94,198	91	0.10
	Malaysia	2019	130,101	182	0.14
		2020	88,845	145	0.16
		2021	26,365	20	0.08
		2022	66,102	56	0.08
		2023	88,911	62	0.07
	Vietnam	2019	320,702	54	0.02
		2020	133,321	19	0.01
		2021	72,880	27	0.04
2022		372,696	151	0.04	
2023		87,719	24	0.03	

<sup>#</sup>Data in 2023 are retrieved as of September 30, 2023

### Clinical Implication of DENV Infection

Some insights are required when we discuss the incidence of DENV infection and its clinical implication. The DENV infection is global in nature, and it is endemic in some parts of the globe. Although a significant population of the world is at risk of infection by DENV, this has not created a significant public health problem from an international perspective. The infection is mostly asymptomatic. Even when they are symptomatic, the primary symptoms are somehow similar to infection with common-cold viruses and other numerous bacteria. During a dengue fever, the patient may develop a high fever, headache, muscle, bone, or joint pain, nausea, vomiting, pain behind the eyes, swollen glands, and rash. Most people with these symptoms recover within a week. However, in some cases, the symptoms worsen, and patients enter into life-threatening situations. These patients are regarded as being “Severe Dengue,” “Dengue Hemorrhagic Fever (DHF),” or “Dengue Shock Syndrome (DSS)”. Death due to DENV infection is usually due to complications such as DHF and DSS.<sup>19,20</sup>

### A BIRD’S EYE VIEW OF DENGUE INCIDENCE AND MORTALITY IN BANGLADESH

Dengue infection has been reported in Bangladesh since 2000. However, neither the health professionals nor the public health authorities were aware of the nature of the disease. During the initial 5 years, considerable numbers of dengue-related deaths were reported. From 2005 to 2015, less than 5000 cases of DENV infection were reported in Bangladesh. Thus, the CFR was high due to low levels of consensus about the reporting system. There was a significant outbreak of dengue in Bangladesh in 2019, with about 101,354 reported cases and 179 deaths. The number of reported dengue cases in Bangladesh fell to 1193 cases in 2020, possibly due to the outbreak of the COVID-19 pandemic. A surge of dengue deaths was seen in 2021 and 2022, with 105 and 281, respectively (Table 2).<sup>21-41</sup>

The outbreak of dengue in 2023 in Bangladesh has broken all previous records. A total of 203,406 cases of dengue have been reported in 2023 (as of September 2023). This figure is higher than the total number of dengue cases reported in Bangladesh from 2000 to 2022 (excluding the number of cases in 2019 when a surge of dengue was recorded). The total number of dengue cases during 22 years from 2000 to 2021, except 2019 was 142,890 cases. Also, the number of deaths due to dengue has already reached 989. The total number of deaths due to dengue in Bangladesh during the last 22 years (2000–2022) was 853 (this includes the deaths of 2019 as well, when a severe outbreak of 101,148 cases was recorded). The CFR value due to dengue over the last 3 years is on a rising trend, and this is also extremely high at 0.49% in 2023.

### CHARACTERISTIC FEATURES OF THE DENGUE OUTBREAK IN 2023 IN BANGLADESH

#### Altered Timing of Dengue Outbreak: Turning from Seasonal Infection to Year-long Endemicity

As shown in Table 3, no case of dengue was reported in Bangladesh from January to May from 2010 to 2012. Most of the cases of dengue were reported during July–October in Bangladesh. This is related to the emergence of the rainy season that favors the breeding of vectors responsible for the transmission of DENV. However, from

**Table 2:** Dengue prevalence in Bangladesh from 2000 to 2023<sup>#</sup>

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023 <sup>#</sup>
Cases	5551	2430	6232	486	3934	1048	2200	466	1153	472	409	1359	671	1749	375	3162	6060	2769	10,148	101,354	1405	28,429	62382	203,406
Deaths	93	44	58	10	13	4	11	0	0	0	6	1	2	0	0	6	14	8	26	164	7	105	281	989
CFR (%)	1.68	1.81	0.93	2.06	0.33	0.38	0.50	0.00	0.00	0.00	1.47	0.07	0.30	0.00	0.00	0.19	0.23	0.29	0.26	0.16	0.50	0.37	0.45	0.49

<sup>#</sup>As of September 30, 2023

2016 onward, dengue cases have been reported in all months of the year. This has been more visible since 2019 when a significant outbreak of dengue was recorded in Bangladesh. In 2023, a total of 175,428 cases of dengue have been reported during peak 3 months (July, August, and September). Additionally, a total of 566 cases of dengue were reported in January 2023. Usually, dengue infection is extremely low in Bangladesh during the winter season (November to January).

**Spread of Dengue Outbreaks over the Entire Country**

Dengue has been traditionally confined to the capital of Bangladesh, Dhaka. This has been found during the last two decades. However, dengue patients have been recorded from all 64 districts of Bangladesh in 2023. Even large outbreaks have been recorded from 10 districts. Thus, it is no longer confined to one or two metropolitan areas.<sup>39</sup>

**Behavioral Changes of the Vector**

According to media reports, behavioral changes among Aedes mosquitoes are rendering mosquito control measures ineffective in Bangladesh. However, other factors may be responsible for these abnormal rises in dengue cases in Bangladesh (The Dhaka Tribune 15/07/2023; FE 15/08/2023, BSS 05/09/2023, and TBS 21/07/2023). There is a need for more research to understand these changes and devise appropriate control measures.

**Distribution of Dengue among all Age-groups in 2023**

Although dengue has mainly been reported among young adults in the literature in Bangladesh, dengue has been recorded among people of all ages in 2023. A total of 11,251 cases of dengue were reported among infants of less than 5 years of age in 2023. As shown in Table 4, most of the dengue cases were detected among the age-group of 21–25 years. Also, maximum fatality was recorded among adults of 21–45 years.

**Dengue Serotypes in 2023 in Bangladesh**

All four serotypes of the dengue virus have been reported in Bangladesh. In fact, serotyping has been accomplished in only a portion of the DENV-infected subjects. DENV serotype 3 has been detected in outbreaks of the early 21st century. Subsequently, DENV-1 and -2 have also been described between 2013 and 2016. After that, both DENV genotypes 2 and 3 have been reported. The WHO said the shift in serotypes may be contributing to more severe infections and hospitalizations when patients are infected for a second time with a different serotype.<sup>40–44</sup>

**FACTORS RELATED TO THE UNPRECEDENTED RISE IN INCIDENCE AND MORTALITY OF DENGUE**

**Environmental Factors**

As per the report from the Global Climate Risk Index 2021, Bangladesh ranked the 7th extreme climate risk-prone country in the world. The World Health Organization (WHO) says dengue has been rising in Bangladesh in recent years partly because of climate change, along with other factors, including the movement of people and goods, urbanization, and problems with sanitation. In fact, currently, Bangladesh has experienced highly favorable environmental factors (unusual sporadic rainfall, unexpected floods, and extreme heatwaves) for breeding DENV-transmitting mosquitos. Also, the number of potential breeding sites of



**Table 3:** Month-wise dengue prevalence in Bangladesh from 2010 to 2023<sup>#</sup>

Month/Year	Dengue cases														14-year average
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
January	0	0	0	6	15	0	13	92	26	38	199	32	126	566	70
February	0	0	0	7	7	0	3	58	7	18	45	9	20	166	21
March	0	0	0	3	2	2	17	36	19	17	27	13	20	111	17
April	0	0	0	3	0	6	38	73	29	58	25	3	23	143	25
May	0	0	0	12	8	10	70	134	52	193	10	43	163	1036	108
June	0	61	10	50	9	28	254	267	295	1884	20	272	737	5956	615
July	61	255	129	172	82	171	926	286	946	16,253	23	2286	1571	43,854	4199
August	183	691	122	339	80	765	1451	346	1796	52,636	68	7698	3521	71,976	8892
September	120	193	246	385	76	965	1544	430	3087	16,856	47	7841	9911	79,598	7614
October	45	114	107	501	63	869	1077	512	2406	8143	163	5458	21,932	–	2782
November	0	36	27	218	22	271	522	409	1192	4011	547	3567	19,334	–	2010
December	0	9	0	53	11	75	145	126	293	1247	231	1207	5024	–	561

<sup>#</sup>As of September 30, 2023

**Table 4:** Demographic distribution of dengue cases and deaths in 2023<sup>#</sup> in Bangladesh

Age-group (Years)	Case			Death		
	Female	Male	Total (% of grand total)	Female	Male	Total (% of grand total)
0–5	4910	6341	11,251 (6)	21	14	35 (4)
6–10	4865	6455	11,320 (6)	30	18	48 (5)
11–15	5151	9666	14,817 (7)	13	14	27 (3)
16–20	8405	17,347	25,752 (13)	26	38	64 (6)
21–25	10,098	20,317	30,415 (15)	50	30	80 (8)
26–30	10,004	16,488	26,492 (13)	49	33	82 (8)
31–35	7810	11,353	19,163 (9)	63	25	88 (9)
36–40	7239	9332	16,571 (8)	61	29	90 (9)
41–45	5379	6574	11,953 (6)	45	29	74 (7)
46–50	4878	5392	10,270 (5)	42	30	72 (7)
51–55	3537	4456	7993 (4)	35	32	67 (7)
56–60	3229	3651	6880 (3)	48	29	77 (8)
61–65	1947	2698	4645 (2)	31	36	67 (7)
66–70	1248	1822	3070 (2)	20	27	47 (5)
71–75	474	840	1314 (1)	10	20	30 (3)
76–80	347	545	892 (0.4)	6	13	19 (2)
>80	242	366	608 (0.3)	7	15	22 (2)
Grand total (%)	79,763 (39)	123,643 (61)	203,406 (100)	557 (56)	432 (44)	989 (100)

<sup>#</sup>As of September 30, 2023

DENV-transmitting mosquitos identified in 2023 is the highest in the last 5 years. Therefore, the climate effect is thought to be playing a significant role in the current surge of dengue transmission in Bangladesh.

### Impact of Prior COVID-19 on the Development of Severe Dengue

Although climate change is thought to exacerbate the breeding of DENV-transmitting mosquitos and may be related to the upsurge of dengue cases in Bangladesh, the underlying pathophysiology

of severe clinical manifestations observed in recent years is poorly understood. There is a concern that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the causative agent for the COVID-19 pandemic, infection interferes with developing severe dengue fever (DF) in recent years,<sup>45–47</sup> yet to prove this with sufficient scientific evidence. With these realities, an association between SARS-CoV-2 infection and the development of severe dengue using a cohort of DF patients who were hospitalized during the mid-COVID-19 time and DENV infection has been suspected (in 2021 and 2022) in Bangladesh.

## Development of Severe Complications due to Antibody-dependent Enhancement (ADE)

Seroprevalence analysis revealed that there are three serotypes of dengue virus (types I, II, and III) dominantly prevailing in dengue hotspot areas of Bangladesh during the last 5 years.<sup>42</sup> Also, some cases with DENV have also been reported. It may be assumed that considerable numbers of dengue patients in recent years have been infected with the DENV before and developed severe disease by inducing ADE because ADE promotes viral replication and contributes to disease pathologies, including vascular hyperpermeability.<sup>48</sup> In fact, dengue reinfection with different serotypes is expected, and the adverse effects of preexisting immune responses to reinfected subjects have been described by several studies.<sup>49</sup> However, clinical characteristics revealed that dengue patients in Bangladesh since 2021 presented some more clinically severe signs than traditional dengue reinfections, indicating the involvement of additional features most likely related to intense immune complexity. Also, like the dengue virus, pieces of evidence have suggested that SARS-CoV-2 can induce ADE.<sup>49–55</sup> Therefore, there is a concern that the antibodies developed due to prior dengue virus and SARS-CoV-2 infection in Dengue patients may enhance severe disease, possibly by ADE. Under these realities, the role of preexisting antibodies against SARS-CoV-2 at the cellular and molecular level in dengue patients should be investigated urgently.

## Possible Genetic Mutation in DENV

Frequent turnover of DENV is one of the main reasons for DENV persistence and prevalence. It has been reported that the serotype of DENV may be responsible for the pathogenesis diversity of dengue patients. There is suspicion that the mutations may be one of the critical mechanisms for virus survival and requisite fitness in the host. Few studies have been accomplished in Bangladesh to define the mutations by undertaking whole-genome sequencing. Thus, it will be difficult to assess the role of mutations during the outbreak of dengue in 2023.

## Poor Healthcare Management

The healthcare delivery system is one of the most important parameters related to the acquisition of DENV and DENV-related fatality. There has been no DENV-dedicated hospital or medical center in Bangladesh. Also, many patients cannot be properly handled in prevailing hospitals, and this is evident in 2023 due to a huge upsurge. This may be related to increased fatality due to DENV as well.

## CONTAINMENT OF DENGUE IN BANGLADESH: AN INCREDIBLE CHALLENGE

It is well-known that the following factors are related to proper control of DENV infection on a global basis. This is also true for Bangladesh. The factors include:

- Vector control.
- Awareness buildup.
- Improve surveillance machinery.
- Improve healthcare facilities.
- Review the patient management strategy.
- Give emphasis on molecular analysis.
- International collaboration.

## SUMMARY AND CONCLUSION

DENV infection is global in nature. However, unusual outbreaks of DENV have been reported in Bangladesh. Although DENV infection has become persistent in Bangladesh over the entire year from 2016, higher incidence and upsurge of DENV were reported from February 2023. This is an exception from other time periods. Also, infants were infected considerably. The death rates surpassed all previous records, and DENV-related deaths in 2023 were higher than the total death due to DENV during 2000–2022. However, molecular analysis of DENV is yet to be accomplished. Containment of DENV and control of DENV-related deaths must be attained immediately by national and international collaboration.

## REFERENCES

1. Go YY, Balasuriya UBR, Lee CK. Zoonotic encephalitides caused by arboviruses: Transmission and epidemiology of alphaviruses and flaviviruses. *Clin Exp Vaccine Res* 2014;3(1):58–77. DOI: 10.7774/cevr.2014.3.1.58.
2. Higuera A, Ramirez JD. Molecular epidemiology of dengue, yellow fever, Zika and Chikungunya arboviruses: An update. *Acta Trop* 2019;190:99–111. DOI: 10.1016/j.actatropica.2018.11.010.
3. Wilder-Smith A, Gubler DJ, Weaver SC, et al. Epidemic arboviral diseases: Priorities for research and public health. *Lancet Infect Dis* 2017;17(3):e101–e106. DOI: 10.1016/S1473-3099(16)30518-7.
4. Gould E, Pettersson J, Higgs S, et al. Emerging arboviruses: Why today? *One Health* 2017;4:1–13. DOI: 10.1016/j.onehlt.2017.06.001.
5. Harapan H, Michie A, Sasmono RT, et al. Dengue: A minireview. *Viruses* 2020;12(8):829. DOI: 10.3390/v12080829.
6. Ferreira GLC. Global dengue epidemiology trends. *Rev Inst Med Trop Sao Paulo* 2012;54(suppl 18):S5–S6. DOI: 10.1590/s0036-46652012000700003.
7. Wright WF, Pritt BS. Update: The diagnosis and management of dengue virus infection in North America. *Diagn Microbiol Infect Dis* 2012;73(3):215–220. DOI: 10.1016/j.diagmicrobio.2012.03.021.
8. Parreira R, Sousa CA. Dengue fever in Europe: Could there be an epidemic in the future? *Expert Rev Anti Infect Ther* 2015;13(1):29–40. DOI: 10.1586/14787210.2015.982094.
9. Eltom K, Enan K, El Hussein ARM, et al. Dengue virus infection in Sub-Saharan Africa between 2010 and 2020: A systematic review and meta-analysis. *Front Cell Infect Microbiol* 2021;11:678945. DOI: 10.3389/fcimb.2021.678945.
10. Brathwaite Dick O, San Martin JL, Montoya RH, et al. The history of dengue outbreaks in the Americas. *Am J Trop Med Hyg* 2012;87(4):584–593. DOI: 10.4269/ajtmh.2012.11-0770.
11. Tapia-Conyer R, Betancourt-Cravioto M, Méndez-Galván J. Dengue: An escalating public health problem in Latin America. *Paediatr Int Child Health* 2012;32(S1):14–17. DOI: 10.1179/2046904712Z.00000000046.
12. Gómez-Dantés H, Willoquet JR. Dengue in the Americas: Challenges for prevention and control. *Cad Saude Publica* 2009;25(1):S19–S31. DOI: 10.1590/s0102-311x2009001300003.
13. Pan American Health Organization. Epidemiological alert: Update on Dengue Situation in the Americas. [updated February 17, 2011; cited December 18, 2011]. Available from: <http://new.paho.org/hq/dmdocuments/2011/EPI-Dengue-Alert-Feb17-2011.pdf>.
14. Martin San JL, Brathwaite O, Zambrano B, et al. The epidemiology of Dengue in the Americas over the last three decades: A worrisome reality. *Am J Trop Med Hyg* 2010;82(1):128–135. DOI: 10.4269/ajtmh.2010.09-0346.
15. Tsheten T, Gray DJ, Clements ACA, et al. Epidemiology and challenges of dengue surveillance in the WHO Southeast Asia Region. *Trans R Soc Trop Med Hyg* 2021;115(6):583–599. DOI: 10.1093/trstmh/traa158.
16. Bhatia R, Dash AP, Sunyoto T. Changing epidemiology of Dengue in Southeast Asia. *WHO South East Asia J Public Health* 2013;2(1):23–27. DOI: 10.4103/2224-3151.115830.

17. Shrestha DB, Budhathoki P, Gurung B, et al. Epidemiology of Dengue in SAARC territory: A systematic review and meta-analysis. *Parasit Vectors* 2022;15(1):389. DOI: 10.1186/s13071-022-05409-1.
18. Hassan MR, Azit NA, Fadzil SM, et al. Insecticide resistance of Dengue vectors in South East Asia: A systematic review. *Afr Health Sci* 2021;21(3):1124–1140. DOI: 10.4314/ahs.v21i3.21.
19. Ranjit S, Kisooson N. Dengue hemorrhagic fever and shock syndromes. *Pediatr Crit Care Med* 2011;12(1):90–100. DOI: 10.1097/PCC.0b013e3181e911a7.
20. Kurane I. Dengue hemorrhagic fever with special emphasis on immunopathogenesis. *Comp Immunol Microbiol Infect Dis* 2007;30(5–6):329–340. DOI: 10.1016/j.cimid.2007.05.010.
21. Bonna AS, Pavel SR, Mehjabin T, et al. Dengue in Bangladesh. *Int J Infect Dis* 2023;51201-9712(23)00644-6. DOI: 10.1016/j.ijid.2023.06.020.
22. Kayesh MEH, Khalil I, Kohara M, et al. Increasing dengue burden and severe dengue risk in Bangladesh: An overview. *Trop Med Infect Dis* 2023;8(1):32. DOI: 10.3390/tropicalmed8010032.
23. Noor R. Reemergence of dengue virus in Bangladesh: Current fatality and the required knowledge. *Tzu Chi Med J* 2020;32(3):227–233. DOI: 10.4103/tcmj.tcmj\_193\_19.
24. Burki T. Bangladesh faces record dengue outbreak. *Lancet* 2023;402(10400):439. DOI: 10.1016/S0140-6736(23)01610-0.
25. Sharmin S, Viennet E, Glass K, et al. 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.
26. Hossain MS, Noman AA, Mamun SMAA, et al. Twenty-two years of dengue outbreaks in Bangladesh: Epidemiology, clinical spectrum, serotypes, and future disease risks. *Trop Med Health* 2023;51(1):37. DOI: 10.1186/s41182-023-00528-6.
27. Cousins S. Dengue rises in Bangladesh. *Lancet Infect Dis* 2019;19(2):138. DOI: 10.1016/S1473-3099(19)30008-8.
28. Haider N, Asaduzzaman M, Hasan MN, et al. Bangladesh's 2023 Dengue outbreak – age/gender-related disparity in morbidity and mortality and geographic variability of epidemic burdens. *Int J Infect Dis* 2023;136:1–4. DOI: 10.1016/j.ijid.2023.08.026.
29. Mutsuddy P, Tahmina Jhora S, Shamsuzzaman AKM, et al. Dengue situation in Bangladesh: An epidemiological shift in terms of morbidity and mortality. *Can J Infect Dis Med Microbiol* 2019;2019:3516284. DOI: 10.1155/2019/3516284.
30. Rafi A, Mousumi AN, Ahmed R, et al. Dengue epidemic in a non-endemic zone of Bangladesh: Clinical and laboratory profiles of patients. *PLoS Negl Trop Dis* 2020;14(10):e0008567. DOI: 10.1371/journal.pntd.0008567.
31. Hasan MM, Sahito AM, Muzzamil M, et al. Devastating dengue outbreak amidst COVID-19 pandemic in Bangladesh: An alarming situation. *Trop Med Health* 2022;50(1):11. DOI: 10.1186/s41182-022-00401-y.
32. Kumar S, Pattnaik R, Subhadra S, et al. Countering Dengue infection in Bangladesh in the backdrop of current outbreak. *New Microbes New Infect* 2023;55:101183. DOI: 10.1016/j.nmni.2023.101183.
33. Haider N, Chang Y-M, Rahman M, et al. Dengue outbreaks in Bangladesh: Historic epidemic patterns suggest earlier mosquito control intervention in the transmission season could reduce the monthly growth factor and extent of epidemics. *Curr Res Parasitol Vector Borne Dis* 2021;1:100063. DOI: 10.1016/j.crvbd.2021.100063.
34. Yesmin S, Sarmin S, Ahammad AM, et al. Epidemiological Investigation of the 2019 Dengue Outbreak in Dhaka, Bangladesh. *J Trop Med* 2023;2023:8898453. DOI: 10.1155/2023/8898453.
35. Hsan K, Hossain MM, Sarwar MS, et al. Unprecedented rise in dengue outbreaks in Bangladesh. *Lancet Infect Dis* 2019;19(12):1287. DOI: 10.1016/S1473-3099(19)30616-4.
36. Mamun MA, Misti JM, Griffiths MD, et al. The dengue epidemic in Bangladesh: Risk factors and actionable items. *Lancet* 2019;394(10215):2149–2150. DOI: 10.1016/S0140-6736(19)32524-3.
37. Islam MA, Hemo MK, Marzan AA, et al. A short communication of 2022 dengue outbreak in Bangladesh: A continuous public health threat. *Ann Med Surg (Lond)* 2023;85(6):3213–3217. DOI: 10.1097/MS9.0000000000000623.
38. Islam MT, Rahman M, Sadia FJ. Outbreak of Dengue amid the COVID-19 pandemic: An emerged crisis for Bangladesh. *Asia Pac J Public Health* 2022;34(4):467–468. DOI: 10.1177/10105395211072841.
39. Sharmin S, Glass K, Viennet E, et al. Geostatistical mapping of the seasonal spread of under-reported dengue cases in Bangladesh. *PLoS Negl Trop Dis* 2018;12(11):e0006947. DOI: 10.1371/journal.pntd.0006947.
40. Malaker R, Sajib MSI, Malaker AR, et al. Genome sequence of a Dengue virus serotype 2 strain identified during the 2019 outbreak in Bangladesh. *Microbiol Resour Announc* 2021;10(1):e01246-20. DOI: 10.1128/MRA.01246-20.
41. Mahmood R, Benzadid MS, Weston S, et al. Dengue outbreak 2019: Clinical and laboratory profiles of dengue virus infection in Dhaka city. *Heliyon* 2021;7(6):e07183. DOI: 10.1016/j.heliyon.2021.e07183.
42. Islam J, Hu W. Heatwaves and Dengue outbreak in Bangladesh after COVID-19 pandemic – An urgent call for climate-driven early warning systems. *Clin Infect Dis* 2023;ciad625. DOI: 10.1093/cid/ciad625.
43. Rahim R, Hasan A, Phadungsombat J, et al. Genetic analysis of Dengue virus in severe and non-severe cases in Dhaka, Bangladesh, in 2018–2022. *Viruses* 2023;15(5):1144. DOI: 10.3390/v15051144.
44. ACAPS Briefing note – Bangladesh 2023 Dengue Outbreak (September 26, 2023). <https://reliefweb.int/report/bangladesh/acaps-briefing-note-bangladesh-2023-dengue-outbreak-26-september-2023#:~:text=The%20dengue%20virus%20has%20affected,Manikganj%2C%20Cumilla%2C%20and%20Faridpur>.
45. WHO details unusual dengue surge in Bangladesh? <https://www.cidrap.umn.edu/dengue/who-details-unusual-dengue-surge-bangladesh>.
46. Khan S, Akbar SMF, Nishizono A. Co-existence of a pandemic (SARS-CoV-2) and an epidemic (Dengue virus) at some focal points in Southeast Asia: Pathogenic importance, preparedness, and strategy of tackling. *Lancet Reg Health Southeast Asia* 2022;4:100046. DOI: 10.1016/j.lansea.2022.100046.
47. Khan S, Akbar SMF, Yahiro T, et al. Dengue infections during COVID-19 period: Reflection of reality or elusive data due to effect of pandemic. *Int J Environ Res Public Health* 2022;19(17):10768. DOI: 10.3390/ijerph191710768.
48. Teo A, Chua CLL, Chia PY, et al. Insights into potential causes of vascular hyperpermeability in Dengue. *PLoS Pathog* 2021;17(12):e1010065. DOI: 10.1371/journal.ppat.1010065.
49. Sarker A, Dhama N, Gupta RD. Dengue virus neutralizing antibody: A review of targets, cross-reactivity, and antibody-dependent enhancement. *Front Immunol* 2023;14:1200195. DOI: 10.3389/fimmu.2023.1200195.
50. Liu Y, Soh WT, Kishikawa JI, et al. An infectivity-enhancing site on the SARS-CoV-2 spike protein targeted by antibodies. *Cell* 2021;184(13):3452–3466.e18. DOI: 10.1016/j.cell.2021.05.032.
51. Katzelnick LC, Coello Escoto A, Huang AT, et al. Antigenic evolution of dengue viruses over 20 years. *Science* 2021;374(6570):999–1004. DOI: 10.1126/science.abk0058.
52. Rodriguez-Roche R, Sanchez L, Burgher Y, et al. Virus role during intraepidemic increase in dengue disease severity. *Vector Borne Zoonotic Dis* 2011;11(6):675–681. DOI: 10.1089/vbz.2010.0177.
53. Chan KWK, Watanabe S, Jin JY, et al. A T164S mutation in the dengue virus NS1 protein is associated with greater disease severity in mice. *Sci Transl Med* 2019;11(498):eaat7726. DOI: 10.1126/scitranslmed.aat7726.
54. Carabali M, Hernandez LM, Arauz MJ, et al. Why are people with Dengue dying? A scoping review of determinants for dengue mortality. *BMC Infect Dis* 2015;15:301. DOI: 10.1186/s12879-015-1058-x.
55. Beatty ME, Stone A, Fitzsimons DW, et al. Best practices in dengue surveillance: A report from the Asia-Pacific and Americas Dengue Prevention Boards. *PLoS Negl Trop Dis* 2010;4(11):e890. DOI: 10.1371/journal.pntd.0000890.