International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 09 | Sept - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Epidemiological Trends and Serotype Dynamics of Dengue in Dhaka, Bangladesh: An Analysis of Expansion, Hyperendemicity and Public Health Perspective (2016 – September 15, 2025)

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ORIGINAL ARTICLE

Abstract

Bangladesh's population is approximately 175.7 million in mid-2025 (UNFPA). Capital city Dhaka is projected to be one of the world's most densely populated urban agglomerations, with an urban population of nearly 24.7 million (World Population Review). This city has faced recurrent dengue epidemics since 2016, including an unprecedented nationwide outbreak in 2019, followed by a major resurgence in 2023.

This paper summarizes the epidemiology of dengue fever in Dhaka from 2016 to September 15, 2025, characterizing shifts in serotypes and genotypes prevalence and discussing implications for public health policy and clinical practices. Surveillance data indicate a transition from the pre-2016 predominance of DENV-1 and DENV-2 to a period of co-circulation in 2018. This was followed by a marked surge of DENV-3 in 2019, primarily driven by Genotype I, with Genotype III also detected. The dominance of DENV-3 was maintained through 2025.

Although outbreak initiation was seasonal-coinciding with pre-monsoon and monsoon periods- their ultimate scale was dictated by the urban landscape, patterns of human movement, and levels of population immunity. Bangladesh grapples with outbreak management challenges due to its tropical climate, fostering year-round mosquito breeding, particularly in densely populated areas like Dhaka. Consequently, a shift in public health strategy is warranted. This necessitates earlier, evidence-based vector control; enhanced surveillance that integrates serotyping and genotyping; risk models informed by serostatus; and targeted, community-driven interventions to eliminate the key containers facilitating the majority of vector propagation.

***Keywords*:** Dengue, Hyperendemicity, Megacity dynamics, Serotype shifts, Climatic forcing, Demovulnerability, Vector control, Bangladesh.

Introduction

Dengue fever has emerged as a major public health crisis in Bangladesh, transitioning from a sporadic illness to a hyperendemic annual threat.

Bangladesh's dengue landscape has become predominantly urban and Dhaka-centered with major, intermittent outbreaks since 2000 which gained momentum from 2016 (Hossain et al., 2023). Dhaka, a megacity with high population density and climatic vulnerability, serves as the epicenter of the country's dengue transmission. Nationally representative and city-specific studies demonstrate extremely high historical exposure in the capital city (≈80% seroprevalence in some communities) (Salje et al., 2019).

The epidemiology is driven by multiple factors in Dhaka: very high population densities, unplanned rapid urbanization, inadequate water storage practices, waterlogging, solid-waste issues, and climate variability. Furthermore, time-series and entomologic investigations in Dhaka reported strong climatic associations with dengue fever and vector indices, as well as seasonal peaks (Hashizume et al., 2012; Islam et al., 2021).

Data and approach

In this narrative synthesis, we review peer-reviewed publications containing primary data or robust reviews concerning the epidemiology of dengue in Dhaka and the spatiotemporal dynamics of its DENV serotypes and genotypes covering the period from 2016 to September 15, 2025.

Epidemiological trends of Bangladesh (2016-September 15, 2025)

The period from 2016-2025 marks a significant intensification of the dengue epidemic. Following a large outbreak in 2019, which recorded 101,354 confirmed cases nationally, the trend has shown an alarming upward trajectory. The 2023 was the most severe in the nation's history, with 321,179 confirmed cases and 1,705 deaths. Case numbers in 2024, 2025 are on a similar - indicating a persistent high-intensity transmission cycle. Epidemiological updates are sourced from the Directorate General of Health Services (DGHS), Bangladesh. The 2025 values are provisional, reflecting data available as of September 15, 2025.

Table 1: Year-wise Dengue Cases and Deaths in Bangladesh (2016-September 15, 2025)

Year	Cases	Deaths
2016	6,060	14
2017	2,769	8
2018	10,148	26
2019	101,354	164
2020	1,405	3
2021	28,429	105
2022	62,382	281
2023	321,179	1,705
2024	101,214	575
2025 (Up to 15 September)	38,527	155

Epidemiology in Dhaka (2016–September 15, 2025)

Following a relatively quiet period the incidence of dengue increased again from 2016 onwards and spiked drastically in 2018–2019 (Muraduzzaman et al., 2018). The 2019 outbreak was the largest one till then, focused initially in Dhaka (Hossain et al., 2020). Dengue reoccurred in 2021 and 2022. 2023 breaks country's records of dengue-related confirmed cases and no. of deaths. Though death rate is low - persistent high-intensity of transmission remains in 2024 and 2025 (DGHS). Over years, the dengue outbreaks in Dhaka repeatedly reach a peak during the monsoon (June–September) (Islam et al., 2021).

Serotypes and Genotypes dynamics (2016–September 15, 2025)

Prior to 2016, DENV-1 and DENV-2 were the most prevalent serotypes in Dhaka (Muraduzzaman et al., 2018). This changed in 2018, when an outbreak was characterized by the co-circulation of DENV-1 and DENV-2 alongside the re-emergence of DENV-3 genotype I (Ahmad et al., 2019). By 2019, DENV-3 had gained prominence as the major serotype (Shirin et al., 2019). Genomic sequencing has confirmed the continued circulation of DENV-3 genotype I from its re-emergence through 2025 (Titir et al., 2021; Rahim et al., 2023; Jahan et al., 2023; Chowdhury et al., 2025).

While the 2023 outbreak in Bangladesh was dominated by DENV-3, the nearby country India has reported co-circulating DENV-4. Multiple studies from 2022-2024 detected DENV-4 genotypes I and II in states such as Kerala, Tamil Nadu, and Delhi suggesting a shift in serotype dynamics across South Asia. The emergence of DENV-4, frequently alongside DENV-1 and DENV-2, indicates increasing viral heterogeneity in the region and raises concerns about cross-border introduction. Given the high volume of travel between Bangladesh and India, the rise of DENV-4 in India underscores the critical need for enhanced regional surveillance and coordinated response plans.

Maternal transmission

DENV is mainly transmitted among humans through mosquitoes, but there's also evidence suggesting potential transmission from a pregnant mother to her baby. Vertical transmission rates seem to be low, and the risk is associated with the timing of the mother's Dengue infection during pregnancy (WHO; August 21, 2025).

Drivers of transmission in Dhaka (2016-September 15, 2025)

The drivers of Dengue transmission in Dhaka from 2016 to the present are a complex interplay of climatic, environmental, urban, and virological factors. The primary driver is the proliferation of *Aedes aegypti* mosquito breeding sites, facilitated by unplanned rapid urbanization, which creates profuse artificial containers like discarded plastic due to inadequate solid waste management (Hasan et al., 2021) and water storage pots necessitated by defective water supply infrastructure. This is compounded by climate change, with rising temperatures accelerating mosquito larval development and viral replication, and unpredictable rainfall patterns enhancing waterlogging and creating new breeding habitats (Ramadona et al., 2019; Islam et al., 2022).

The high population density and mobility in Dhaka ensure a constant reservoir of susceptible and infected hosts, a key factor in the initial establishment of the virus in the region (Banu et al., 2011). Festival-related mobility spreads infections from Dhaka to other districts and vice-versa (Hossain et al., 2020). Furthermore, the co-circulation of multiple dengue serotypes increases the risk of severe disease through antibody-dependent enhancement (Khatun et al., 2022; WHO, 2023).

These factors collectively create a highly conducive environment for endemic and often explosive seasonal transmission, with record-breaking outbreaks occurring in years like 2019, 2023, and 2024.

Gender distribution of Dengue affected cases and Deaths in Bangladesh (1 January-15 September 2025)

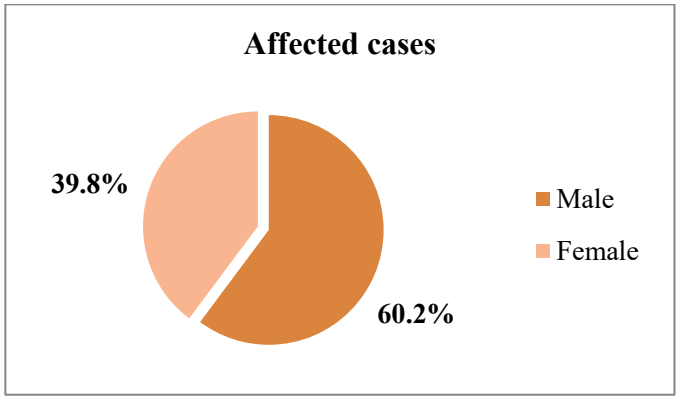


Figure 1: Gender distribution of Dengue affected cases in Bangladesh (1 January-15 September 2025)

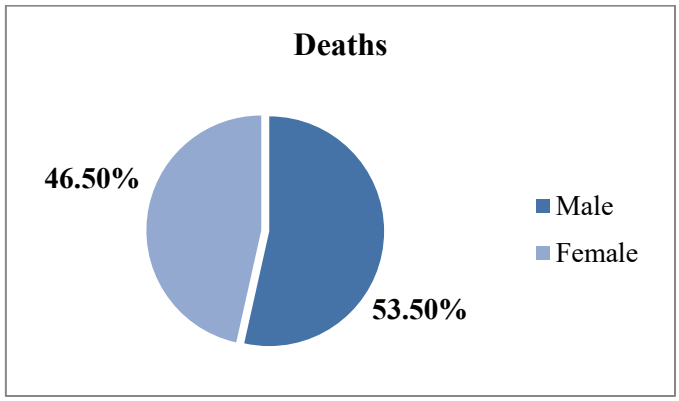


Figure 2: Gender distribution of Deaths in Dengue in Bangladesh (1 January-15 September 2025)

Dengue affected cases and Deaths reported from Dhaka city (DNCC+DSCC) and from outside Dhaka city (1 January-15 September 2025) (DNCC=Dhaka North City Corporation DSCC=Dhaka South City Corporation)

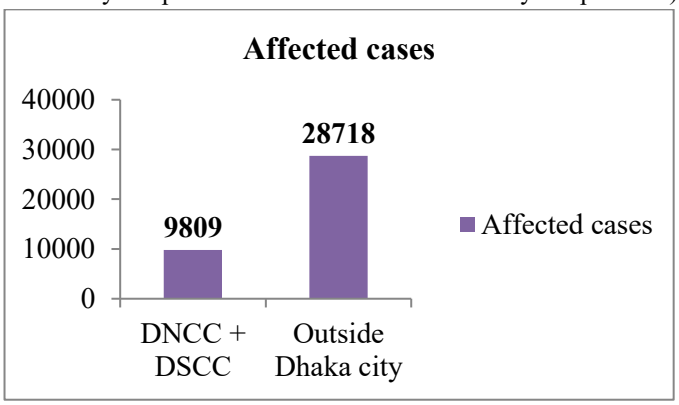


Figure 3: Dengue affected cases reported from Dhaka city and from outside Dhaka city (1 January-15 September 2025)

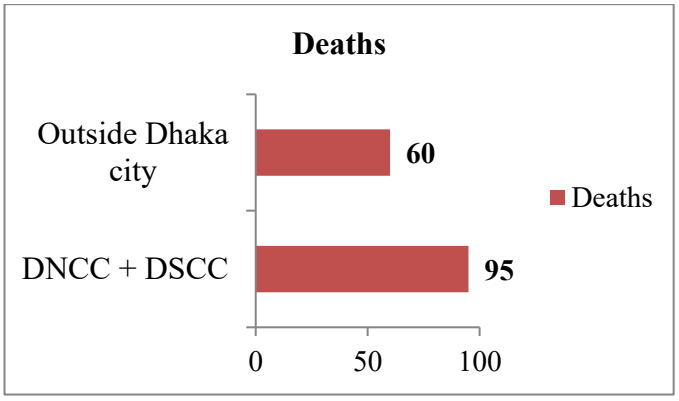


Figure 4: Deaths due to Dengue in Dhaka city (DNCC+DSCC) and outside Dhaka city (1 January-15 September 2025)

The 2023 Dengue catastrophe in Dhaka

The 2023 dengue outbreak was the most severe in Bangladesh's history, with a national total of 321,179 cases and 1,705 deaths, the brunt of which fell on Dhaka. This unprecedented surge exceeded all previous records, overwhelming hospitals and straining clinical care capacity. The outbreak's severity was driven by several factors: the predominance of DENV-3 circulation, high population susceptibility following previous serotype waves (Clapham et al., 2017; Guzman et al., 2013), powerful monsoon rains (Islam et al., 2021), and dense urban landscapes that perpetuated the breeding of *Aedes aegypti* mosquitoes (Ferdousi et al., 2015; Paul et al., 2018). It identified systemic failures in early warning, vector control, and hospital surge preparedness, reinforcing the need for sustained climate-informed dengue prevention strategies.

These findings corroborate previous research linking serotype dynamics, climatic forcing, and container ecology to wave-like increases in dengue morbidity and mortality in Dhaka (Hossain et al., 2020; Shirin et al., 2019), creating a case study relevant to many regions experiencing expanding dengue numbers and spread.

Monthly Dengue cases and Deaths in Bangladesh (2023)

Table 2: Monthly Dengue cases and Deaths in Bangladesh (2023)

Months	Cases	Deaths
January	566	6
February	166	3
March	111	0
April	143	2
May	1,036	2
June	5,956	34
July	43,854	204
August	71,976	342
September	79,598	396
October	67,769	359
November	40,716	274
December	9,288	83
Total	**321,179**	**1,705**

Gender distribution of Dengue affected cases and Deaths in Bangladesh (2023)

During Bangladesh's 2023 dengue outbreak, a significantly higher number of men were infected, but the disease proved more fatal for women. While males accounted for 192,610 (60%) cases compared to 128,569 (40%) female cases, fatalities were higher among women, with 970 (57%) female deaths versus 735 (43%) male deaths (DGHS).

Table 3: Seasonal occurrences of Dengue in Bangladesh (2023)

Season	Months	Share of Cases
Pre-monsoon	March-May	<5% (sporadic, low incidence)
Monsoon	June-September	Peak (~60–65% annually; July 2023 alone ≈63%)
Post-monsoon	October-November	~30–35% (notably Aug–Oct 2023 ≈68% cases, 64% deaths)
Winter	December-February	<5% (minimal, sporadic)

Sift of seasonality of Dengue cases in Bangladesh (2016–2025)

Seasonality has also expanded; outbreaks nowadays frequently begin as early as March and extend into late November, suggesting year-round transmission in Dhaka.

Surge in Dengue cases and Fatalities overwhelms Hospitals in 2025

Bangladesh is confronting a dengue outbreak again in 2025, with national newspapers reporting an alarming rise in cases, hospitalizations, and deaths. Critical situations unfolded in Dhaka hospitals again.

Health specialists attribute the escalation to notable precipitation and inadequate waste disposal, which created an ideal breeding environment for Aedes mosquitoes. They further emphasized that the ineffective and poorly timed application of vector control measures significantly contributed to the surge.

Although daily mortality figures have recently reached a temporary plateau, public health authorities warn that the high morbidity and mortality rates observed in July and August are strong predictors of further increases unless urgent and serious containment measures are implemented. This persistent rise in morbidity underscores a growing public health burden, which remains a serious concern despite a recent declining trend in dengue-related mortality.

While the majority of hospitalizations are concentrated in Dhaka, Barishal and Chattogram division and others are also experiencing significant caseloads. (Prothom Alo & Jugantor, September 2025).

Limitations of the evidences

Data from hospitals might represent care-seeking bias (Hossain et al., 2020). Serotypes and genotypes results are based on hospital sampling and not population based testing (Rahim et al., 2023). Intervention evidence is mostly observational (Cavany et al., 2020).

Public health implications for Dhaka

The high population density, unplanned urbanization, and inadequate waste management in Dhaka create ideal conditions for the *Aedes aegypti* mosquito to breed, primarily in stagnant water in discarded containers and water storage systems (Hossain et al., 2023). Controlling dengue in this megacity requires a multi-faceted public health strategy that moves beyond reactive insecticide spraying. This includes robust community-based source reduction campaigns (e.g., removing stagnant water), improved solid waste management, and public education on preventive measures (WHO, 2012).

Regional serotyping and genotyping should become part of surveillance (Rahim et al., 2023; Sarkar et al., 2023). Preparing to maintain dengue diagnostics and clinical capabilities, even during other emergencies, such as COVID-19, would help ensure continuity of essential services at times of public health emergency (Hossain et al., 2022).

Furthermore, enhancing clinical management through physician training and ensuring adequate medical supplies are crucial to reduce case fatality rates (Dhaka South City Corporation & Dhaka North City Corporation, 2022). Sustainable control hinges on integrated vector management, strengthened surveillance for early outbreak detection, and community engagement to foster long-term co-operation, which must also consider the amplifying effects of climate change (Banu et al., 2011).

Dengue impact on the achievements of Sustainable Development Goals (SDGs)

Since 2016, a rising dengue burden in Dhaka has significantly hindered the achievement of various SDGs. Its impact extends beyond health, affecting the social, economic, and environmental dimensions central to sustainable development.

SDG 3- Good health and well-being: Repeated dengue outbreaks cause widespread morbidity and mortality, placing a severe strain on healthcare systems. The burden falls hardest on vulnerable groups like children, elderly, and others with low access to medical care. By overwhelming medical resources, these outbreaks also deprive other health services of funding and personnel, ultimately obstructing progress toward universal health coverage.

SDG 6- Clean water and sanitation: Poor water management, sanitation, and waste disposal create stagnant water that upholds Aedes mosquito breeding and increases dengue transmission. Addressing this requires improved water storage, drainage, and sanitation facilities to eliminate these environmental risk factors.

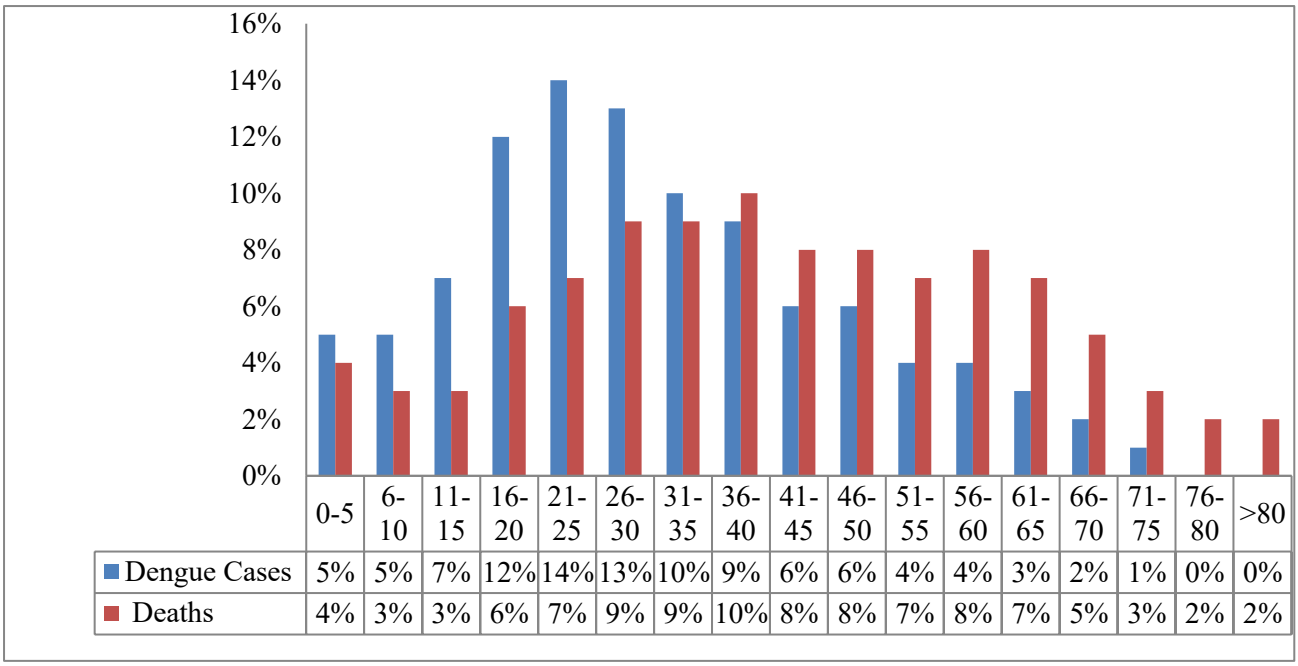
SDG 11- Sustainable cities & communities: Rapid urbanization in Dhaka, its dense population, and widespread informal settlements have increased dengue susceptibility. Outbreaks damage livelihoods, mobility, and community resilience, undermining the vision of a sustainable city. Enhancing urban planning, housing, and vector control is vital to prevent frequent epidemics.

SDG 13- Climate action: Rising temperatures, shifting rainfall, and higher humidity foster mosquito development, spreading dengue. This highlights the health impacts of climate change, necessitating adaptive public health measures and interdisciplinary collaboration to mitigate risks.

SDG 15- Life on land: The disruption of ecological balance through uncontrolled urbanization, deforestation, and land-use change promotes the propagation of disease vectors. To regulate the spread of these diseases and maintain biodiversity, sustainable urban and environmental development must be integrated with ecosystem management.

To align with the Sustainable Development Goals, dengue control must be prioritized on public health and development agendas. An effective response requires multi-sectoral action - including healthcare capacity building, investment in water and sanitation, climate-resilient policies, and robust community participation. Successfully addressing dengue reduces the disease burden while simultaneously accelerating progress across a range of SDGs.

Age group distribution of Dengue affected cases and Deaths in Bangladesh (2023)



	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	>80
Dengue Cases	5%	5%	7%	12%	14%	13%	10%	9%	6%	6%	4%	4%	3%	2%	1%	0%	0%
Deaths	4%	3%	3%	6%	7%	9%	9%	10%	8%	8%	7%	8%	7%	5%	3%	2%	2%

Figure 5: Age group distribution of Dengue affected cases and Deaths in Bangladesh (2023)

Conclusion

Between 2016 and 2025, Dhaka underwent a significant epidemiological transition as the dominant dengue serotype shifted from DENV-1 and DENV-2 to DENV-3. Research indicates that this shift, combined with seasonal climatic forces, container-driven mosquito ecology, human mobility, and changing population immunity, generated successive severe outbreaks. To effectively combat this evolving threat, the city requires a proactive strategy that implements container-focused vector control, enhances surveillance with virological data to track serotypes, and ensures hospital preparedness is tailored to these specific dynamics (Sources: Shirin et al., 2019; Titir et al., 2021; Bowman et al., 2016; Cavany et al., 2020).

Dengue fever represents a persistent and significant public health challenge in Bangladesh, straining healthcare infrastructure and impacting population health. The nation's tropical monsoon climate, rapid urbanization, and essential water storage practices create ideal ecological niches for the *Aedes aegypti* mosquito. Mitigating the burden of this disease requires a multi-faceted strategy that integrates enhanced healthcare system capacity with proactive community engagement and public awareness campaigns. Government leadership, supported by targeted research and international collaboration, is pivotal. Comprehensive

Interventions including sustainable vector control, strengthened surveillance for early outbreak detection, and standardized treatment protocols - critical to reducing the impact of dengue.

Sustained investment and vigilance in these preventive measures are essential for building a resilient, dengue-resistant future for Bangladesh.

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