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Review article

The potential resurgence of Dengue Virus-4: A novel epidemiological pattern and altered symptomatology in Bangladesh

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ABSTRACT

Dengue fever is a viral illness spread by infected *Aedes* mosquitoes and originates from one of five dengue virus serotypes (DENV 1-5). Recently, the epidemiology of DENV has become a major concern worldwide. DENV can be prevalent in both urban and semi-urban areas across the tropical and sub-tropical continents, and over half of the global population is at risk of contracting dengue fever. Bangladesh has experienced a significant rise in reported cases of endemic dengue in recent years. Specifically, notable increases were observed in 2018, 2019, 2021, 2022, and 2023. Alongside, there was also a higher number of fatalities reported in these regimes. During July 2025, there was a sharp increase in the prevalence of dengue-related infections and associated mortality. Specifically, a cumulative number of 6,099 infected cases, with a corresponding fatality rate of 61. This severe and potentially fatal case of dengue suggested the possible re-emergence of DENV-4 in Bangladesh. Also, the resurgence and predominance of the DENV-4 serotype this year may explain the development of atypical symptomatology. Also, the rise in dengue cases in the country could be associated with an alteration in the biting behaviors of mosquitoes carrying the virus. However, the control of DENV infection remains a significant challenge due to the lack of effective vaccines for all serotypes of DENV. In light of the ongoing situation, the government is faced with the necessity of implementing measures by the preventive guidelines established by the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO).

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1. INTRODUCTION

Dengue fever, a mosquito-borne viral disease caused by the dengue virus (DENV), has evolved into a pressing global public health challenge, particularly in tropical and subtropical regions (Bhatt et al., 2013; Zerfu et al., 2023). Bangladesh, with its conducive climate and densely populated urban centers, has experienced a worrying surge in dengue incidence over recent decades. The disease presents in varying degrees of severity—from mild febrile illness to life-threatening forms such as dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS) (WHO, 2009; Zerfu et al., 2023). Atypical symptoms such as gastrointestinal issues, brain inflammation, and

severe abdominal pain have become increasingly common, complicating timely diagnosis and care (Nimmagadda et al., 2014).

A major concern is the emergence and shift of circulating DENV serotypes over time. While DENV-1 dominated early outbreaks, recent years have seen a transition to DENV-2 and DENV-3, with the reappearance of DENV-4 after nearly a decade-long absence (Bhowmik et al., 2023). Adding complexity to the dengue epidemic is the evolving behavior of its vector, *Aedes aegypti*. Traditionally active during daylight, recent studies suggest that artificial light at night may alter mosquito activity, potentially extending biting hours into the evening and night (Rund et al., 2020; Chadee & Martinez, 2000). Furthermore, *Aedes* larvae are now found in diverse aquatic habitats-including sewage and saline water-demonstrating remarkable adaptability that undermines traditional vector control strategies (Sultana, 2023).

Given the persistence of dengue outbreaks, the lack of a universally effective vaccine, and increasing resistance of mosquito vectors to control measures, Bangladesh faces significant challenges. In this context, comprehensive research is essential to understand the evolving epidemiological patterns, clinical presentations, serotype dynamics, and behavioral shifts of dengue vectors. This study seeks to explore the prevalence of dengue in Bangladesh, assess mortality trends, and investigate the altered symptomatology and nocturnal biting characteristics, aiming to inform future public health interventions and disease management strategies.

2. EPIDEMIOLOGICAL PATTERN

Dengue fever is an infectious disease caused by the dengue virus (DENV) that has emerged as a significant public health concern with global implications, particularly in countries located in tropical and subtropical regions (Bhatt et al., 2013; Zerfu et al., 2023). The majority of DENV infections are asymptomatic; however, they have the potential to manifest in a variety of clinical representations, ranging from a mild febrile illness to severe conditions such as hemorrhagic dengue fever (DF) or dengue shock syndrome (DSS) (Bhatt et al., 2013; WHO, 2009; Zerfu et al., 2023).

The data from 2000 to 2025 in Bangladesh indicates that there was a notable increase in reported cases of endemic dengue in the years 2018, 2019, 2021, 2022, and 2023, followed by an elevated number of fatalities (Fig. 1) (Bhowmik et al., 2023; Haider et al., 2023). According to reports, the fatality rate experienced fluctuations over the years. The highest fatality rate was recorded between 2000 and 2003, while the lowest occurred from 2004 to 2010 (Fig. 2) (Bhowmik et al., 2023; Haider et al., 2023). However, recent trends suggest that the fatality rate increased in 2023, which is expected to increase once again in 2025. Since 2000, there has been consistent documentation of annual occurrences of endemic dengue cases in Bangladesh. Notably, a significant proportion, specifically over 92%, of these cases are reported in major urban areas during August and September (Haider et al., 2023; Sharmin et al., 2018). Intense rainfall and warm temperatures, which favor mosquito reproduction, have led to an increase in confirmed cases throughout these two months (World-Bank, 2021).

The incidence of dengue cases in Bangladesh has shown a consistent pattern based on previous data. Between the years 2008 and 2022, it has been observed that the number of dengue cases exhibits an upward trajectory in April, reaching its peak in July (Bhowmik et al., 2023; Haider et al., 2023). However, after August, there is a rapid decline in the number of reported cases. This pattern highlights the seasonal adaptation of DENV in Bangladesh, with a clear trend of increasing cases followed by a decline in the later months (Ahsan et al., 2021; Haider et al., 2021a; Haider et al., 2023). According to the latest bi-annual report released on 18thJuly 2025, the country has recorded a staggering61 deaths related to dengue fever (DGHS, 2025; UNICEF, 2023). During the middle of the year 2025, the month of July witnessed the highest monthly incidence of dengue-related cases, with a total of 6,099 reported cases (Fig. 3). Additionally, this month also recorded the highest number of deaths associated with dengue, with a total of 19 fatalities (Fig. 4) (DGHS, 2025; UNICEF,

2023).These numbers are quite remarkable when compared to the country's previous pattern of DENV epidemiology (Haider et al., 2021a).

3. CIRCULATING SEROTYPE AND ALTERED SYMPTOMATOLOGY

DENV is mostly transmitted by the bites of certain mosquito species, namely *Aedes aegypti* and *Aedes albopictus* (Haider et al., 2023). These mosquitoes act as vectors, carrying the virus from an infected person to a healthy individual. In the context of Bangladesh, it is noteworthy that both mosquito species are quite prevalent (Haider et al., 2023; Rahman et al., 2021). The DENV is known to exist in multiple serotypes, with each serotype having distinct characteristics. To date, five serotypes of DENV have been identified: DENV-1, DENV-2, DENV-3, DENV-4, and DENV-5 (Bhowmik et al., 2023; Haider et al., 2023). In Bangladesh, a country dealing with the burden of dengue fever, four out of the five known serotypes have already been reported, specifically, DENV-1, DENV-2, DENV-3, and DENV-4 (Hamel et al., 2019; Muraduzzaman et al., 2018; Normile, 2013).

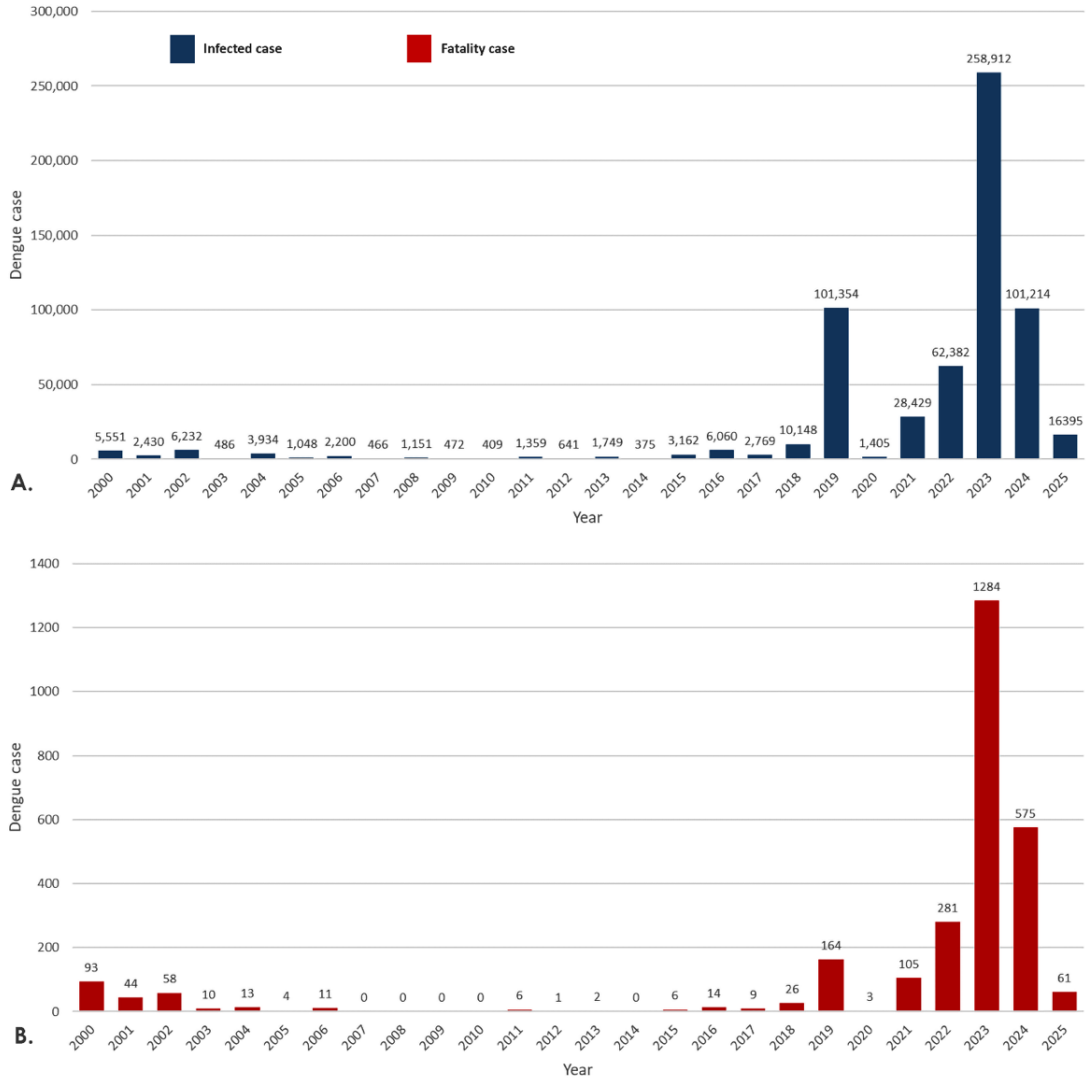

Figure 1. Trends in dengue prevalence (A) and associated case fatalities (B) in Bangladesh from 2000 to 2025, with data reported up to July 18, 2025. Source: Directorate General of Health Services (DGHS), 2025.

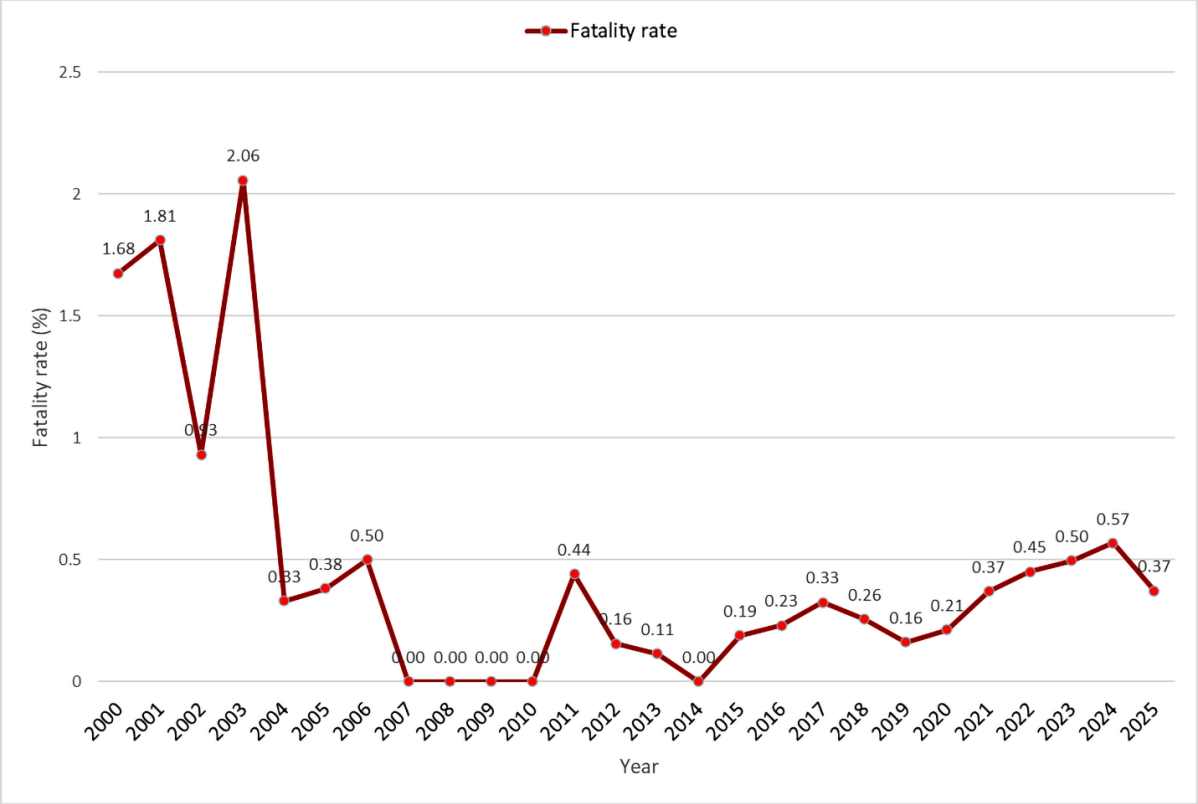

Figure 2. Fatality rate of dengue-related cases in Bangladesh between 2000 and 2025, based on data reported up to July 18, 2025.Source: Directorate General of Health Services (DGHS), 2025.

Until 2013, the majority of DENV cases were attributed to the DENV-1 serotype (Bhowmik et al., 2023). However, from 2013 to 2018, DENV-2 emerged as the predominant DENV serotype, while only a limited number of DENV-1 cases were reported. Furthermore, the DENV-3 serotype was introduced in the latter part of 2018 and emerged as the dominant serotype, accounting for 91.9% of reported cases, during the outbreak in 2019 (Bhowmik et al., 2023; Rahim et al., 2021; Rahman et al., 2021; Shirin et al., 2019). In 2021, 100% of the dengue cases were attributed to the DENV-3 serotype in the country (Bhowmik et al., 2023; Rahim et al., 2021). In Bangladesh, DENV-4 had not been reported since 2013, suggesting a decline or absence of this serotype in the country. However, the recent findings indicate that DENV-4 made a comeback in late 2022, raising concerns among health authorities and experts (Bhowmik et al., 2023; WHO-Bangladesh, 2023). Dhaka, the capital city of Bangladesh, is currently facing a concerning situation as there are suspicions of the re-emergence of DENV-4 (Bhowmik et al., 2023; Rahim et al., 2021; Shirin et al., 2019; Tahmina, 2022). In a recent report by the Institute of Epidemiology, Disease Control, and Prevention (IEDCR), it has been revealed that DENV-4 was found in approximately 11% of the samples collected, while DENV-3 was detected in a significant number of the samples, accounting for approximately 89% of the dengue cases (Bhowmik et al., 2023; Haider et al., 2023; Shirin et al., 2019; Tahmina, 2022). According to these reports, there are indications of a potential outbreak of DENV in 2023. The reports also suggest that the DENV-4 serotype may be the most prevalent strain during this outbreak. Although the origin of DENV-4 is unidentified, there is a possibility of transmission of the virus from neighboring nations where the serotype has been in circulation for an extended period (Gowri Sankar et al., 2021; Nonyong et al., 2021; Rehman et al., 2022). According to a study conducted by Salje et al. (2016), the DENV-4 serotype was not found in the country; however, since the majority of the population has already been infected with other serotypes, there is now

an increased risk of secondary infection with DENV-4 (Morales et al., 2016).In July 2023, there was a concerning surge in the death toll and a significant increase in the number of dengue cases (DGHS, 2025). This alarming trend has led experts to speculate that the entire country may be experiencing a secondary infection of the DENV-4 serotype.

Recent research suggests that the probability of developing a severe and potentially fatal form of dengue increases with each consecutive infection with a new serotype (Bhowmik et al., 2023; Gibbons and Vaughn, 2002).However, the interaction between the virus and the immune system, as well as the potential impact of pre-existing immunity on disease, remains unclear (Bhowmik et al., 2023).

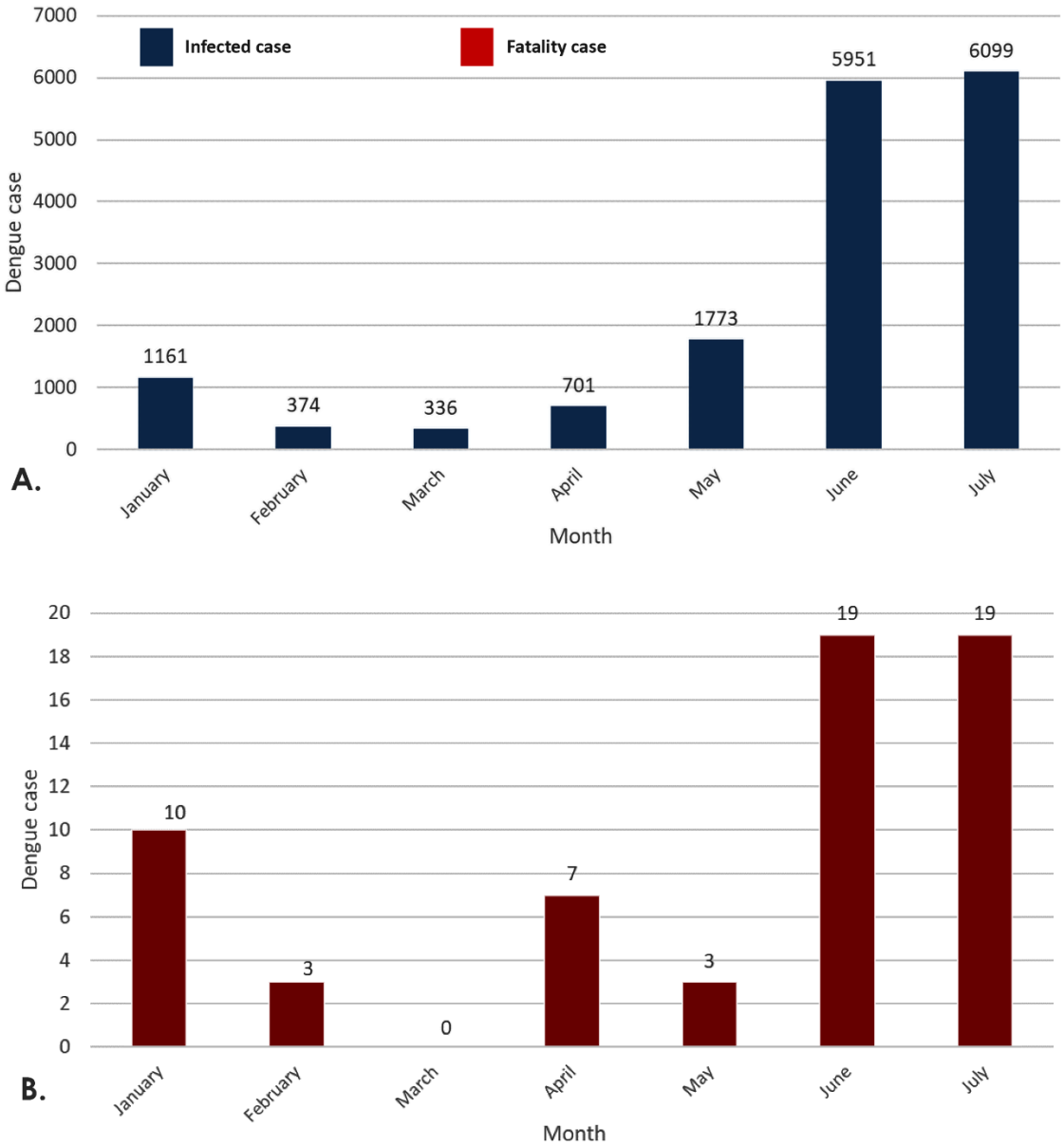

Figure 3. Prevalence of dengue-related infections (A) and associated fatalities (B) in Bangladesh during 2025, with data reported up to July 18, 2025. Source: Directorate General of Health Services (DGHS), 2025.

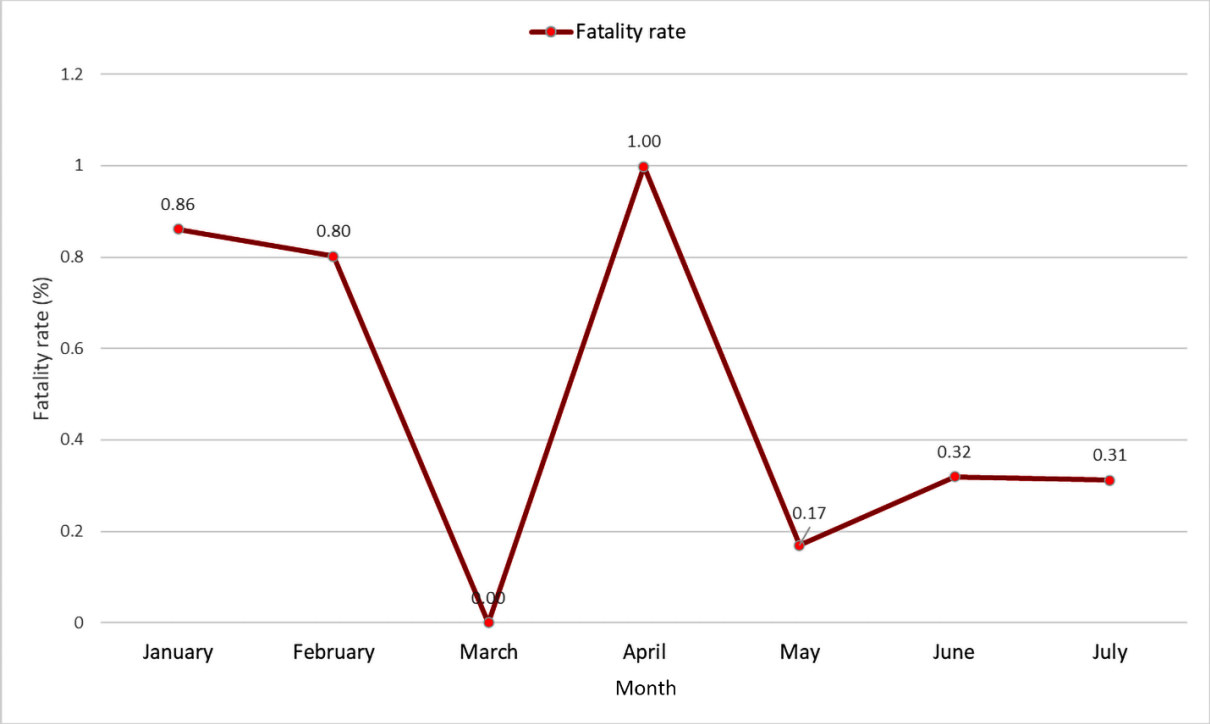

Figure 4. Fatality rate of dengue-related infections in Bangladesh during 2025, based on data reported up to July 18, 2025. Source: Directorate General of Health Services (DGHS), 2025.

Researchers have a belief that recovery from DENV infection is dependent on adaptive immunity. However, recent studies have shown that co-infection with multiple serotypes of the virus may only offer temporary and insufficient protection, and in fact, increase the risk of developing severe DENV infection (Ali et al., 2021). The symptoms of dengue fever bear resemblance to those commonly associated with the common cold and influenza, leading to ambiguity regarding the diagnosis and treatment of DENV infection (Ali et al., 2021; Bhowmik et al., 2023; Mustafa et al., 2018; Rahman et al., 2021). Importantly, this year in Bangladesh, atypical symptoms such as diarrhea, low-grade fever or no fever, vomiting, brain inflammation, pleural effusion, ascites, and intense stomach pain have been obtained from the majority of dengue cases (Hasan et al., 2025). These symptoms are more prevalent in people who have had a second or third dengue infection. As per the analysis of certain medical experts, individuals afflicted with dengue fever experienced serious complications such as weak pulse rate and decreased blood pressure, even in the presence of mild fever, cold symptoms, and headache (Hasan et al., 2025). Consequently, this phenomenon could be attributed to the re-emergence of the DENV-4 serotype and its dominant prevalence. As a consequence of these aforementioned concerns, individuals seeking medical attention are arriving at healthcare facilities at a delayed stage, often unable to recognize the altered manifestation of typical dengue signs and symptoms (Hasan et al., 2025).

4. DIURNAL BEHAVIOR

The larvae of the DENV vector mosquito prefer artificial or natural water containers near human residences, such as water storage containers, flowerpots, discarded tires, plates under potted plants, cemetery vases, buckets, tin cans, clogged rain gutters, ornamental fountains, drums, pet water bowls, birdbaths, etc. The larvae have also been observed in subterranean reservoirs of water, including exposed or unsealed septic tanks, storm drains, wells, and water meters (CDC, 2023; WHO-Bangladesh,

2023; WHO, 2009). The research conducted between 2021 and 2023 investigated the adaptability of *A. aegypti* mosquito larvae to various aquatic environments, such as sewage, sea, brackish, and drain water. The findings indicate that *A. aegypti* mosquitoes possess the ability to reproduce in diverse water sources, encompassing rainwater, saltwater, seawater, drain water, and sewage water (Sultana, 2023). The study revealed that the *Aedes* mosquito can survive at an impressive rate of 95.83% in these different water types. However, it was observed that the mosquito's survival rate slightly dropped to 92% when exposed to sewage water (Sultana, 2023). These findings highlight the resilience and versatility of the *Aedes* mosquito, providing valuable insights into its ability to persist in diverse environments. This presents a novel challenge for endeavors aimed at dengue control, as these mosquitoes have demonstrated an ability to adapt and flourish in diverse aquatic habitats (Sultana, 2023).

A, aegypti exhibits diurnal behavior, being active during the daytime. This species exhibits a distinct flight activity and biting behavior in the early morning, followed by a second, more extended period of activity in the afternoon (Rund et al., 2020). The termination of this activity occurs either during or at the end of dusk. In general, it was observed that there is minimal to no flight activity or biting from this mosquito species during the night (Chadee, 1988; Clements, 1999; Rund et al., 2020). However, recent studies have shed light on the potential consequences of artificial light at night on wild populations of *A. aegypti* mosquitoes, which could lead to an increased risk of disease transmission (Rund et al., 2020). While it is primarily known to be active during the daytime, there have been occasional observations of nocturnal biting behavior in this mosquito species (Chadee and Martinez, 2000; Clements, 1999). The current understanding is that nocturnal light can stimulate blood feeding in *A. aegypti* mosquitoes, which has raised concerns about the potential role of artificial light in increasing the risk of arboviral disease transmission (Chadee and Martinez, 2000; Clements, 1999). This finding holds significant epidemiological implications as it reveals an understanding of the potential link between artificial light and the biting rate of these disease-carrying vectors. This is due to its tendency to prefer human-inhabited areas, making it more likely to be exposed to artificial lighting regularly (Clements, 1999).

In recent times, there has been a growing concern among medical experts regarding the rise in dengue cases in Bangladesh. These specialists have put forth a hypothesis suggesting that this increase may be attributed to a change in the biting behavior of the dengue-carrying mosquitoes in the country (Sultana, 2023). With the advent of modernization, the excessive use of artificial light in streets, households, and markets has been claimed to have unintended consequences. According to the experts, this overabundance of artificial light may confuse certain vectors, such as dengue-carrying mosquitoes and even stimulate them to bite during nighttime hours (Sultana, 2023).

5. FUTURE PROSPECTS

Managing dengue fever outbreaks in tropical areas poses a significant challenge due to the favorable conditions for mosquito reproduction and viral replication (Bhowmik et al., 2023). The year-round warm temperatures in these regions create an environment that is highly conducive to the spread of the disease (Bhowmik et al., 2023; Haider et al., 2021b). According to a report by Channel 2023, Yangon City in Myanmar experienced a total number of 483 confirmed cases of dengue fever, resulting in 3 fatalities, by mid-2023 (MITV, 2023). The dengue virus has been causing significant impacts in several cities across India. As of July 31, 2023, the National Centre for Vector Borne Disease Control (NCVBDC) has reported a concerning number of cases related to dengue fever. According to their most recent data, a total of 31,464 cases have been documented across multiple cities. Tragically, this outbreak has resulted in 36 fatalities (NCVBDC, 2023). Similarly, like these Southeast Asian countries in close proximity, Bangladesh has emerged as a favorable environment for the DENV owing to its geographical location and subtropical or tropical climate. Consequently, this has resulted in a rise in the transmission of the DENV (Mutsuddy et al., 2019). Bangladesh National Health Accounts (BNHA) study shows that

dengue negatively impacts the health sector economy, as it does in other low- and middle-income nations (Bhowmik et al., 2023; Mustafa et al., 2018). To mitigate the risk of contracting dengue fever, it is crucial to develop a dengue vaccine that is both safe and effective. This vaccine should provide significant and long-lasting protection against all four serotypes of the dengue virus (Robert Putnak et al., 2005). Furthermore, it is crucial to emphasize the significance of illness awareness within a population and the adoption of health-related behaviors as fundamental components in the prevention of diseases (Alyousefi et al., 2016). The people of Bangladesh are currently facing a significant challenge as they remain largely unaware of a potentially life-threatening illness. This lack of awareness has created a concerning situation, as individuals are not equipped with the knowledge needed to protect themselves from this disease (Bhowmik et al., 2023). In the context of the mounting incidence of dengue cases in Bangladesh and the recent surge in dengue-related mortality in Dhaka, the country's most densely populated urban center, it is vital to consistently assess the educational attainment, awareness levels, and preventive measures implemented among the local population as a whole (Bhowmik et al., 2023; Haider et al., 2023).The most effective approach to control dengue is the implementation of the preventive measures targeting the vector, as recommended by the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) (CDC, 2023; WHO-Bangladesh, 2023). These approaches prioritize interventions aimed at reducing the population of disease-carrying vectors, rather than solely focusing on protecting individuals from mosquito bites (CDC, 2023; WHO-Bangladesh, 2023). Currently, there are no effective vaccines available for all serotypes of DENV. Considering the current situation, the government finds itself with no alternative but to take action in line with the preventive guidelines formulated by the CDC and WHO. Hence, the main objective of this study was to investigate the prevalence of dengue and the mortality rate attributed to this ailment, to offer a comprehensive understanding of the dengue epidemic in Bangladesh, along with its altered signs and symptoms, seroconversion, and nocturnal biting characteristics.

COMPETING INTEREST

The authors declare there are no competing interests.

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AUTHORS' CONTRIBUTIONS

Dr. Abanti Barua: Conceptualization, Methodology, Writing- Original draft preparation, Visualization, Investigation, Validation, Writing- Reviewing and Editing.

Md. Habib Ullah Masum: Methodology, Writing- Original draft preparation, Visualization, Investigation, Validation, Writing- Reviewing and Editing.

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