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Review Article

A Nation in the Grip of Dengue: How Climate, Pollution, and Urbanization Are Feeding a Relentless Killer—The Mosquito

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Abstract

Dengue has emerged as a persistent and escalating public health crisis in Bangladesh, reflecting both local vulnerabilities and a broader global threat. Between 2023 and 2025, the outbreaks have caused substantial morbidity and mortality across all age groups, driven by rapid urbanization, dense populations, poor sanitation, and climatic changes. Environmental degradation, including loss of green cover, pollution, and plastic accumulation, has further intensified mosquito proliferation, while demographic shifts reveal increasing vulnerability among children, juveniles, and young adults. Immediate, coordinated action—including strengthened public health infrastructure, vector control, and community awareness—is imperative to curb the ongoing outbreaks and mitigate the potential for regional and global spread.

Keywords: dengue epidemiology; aedes mosquito breeding; pandemic outbreaks; climate-driven transmission; urbanization impact; insecticide resistance; public health burden; micro plastic environmental risk

Introduction

Each year, mosquitoes wage a silent war—infecting about 700 million people and killing more than one million worldwide [1]. Mosquito-borne viruses such as dengue, chikungunya and Zika carry a staggering global economic toll: over 45 years, in 166 countries, they have cost an estimated US $95 billion—and from 2013 to 2022 the cost rose 14-fold, far outpacing spending on prevention and control [2].

The global epidemic of dengue is believed to have emerged in Asia and the Pacific region during and following World War II [3]. While malaria continues to strike hardest in Africa—with over ninety percent of cases and deaths occurring in WHO-designated African nations, particularly in sub-Saharan regions [4]—Asia bears the greatest burden of dengue, accounting for nearly seventy percent of all global cases [5]. Within Asia, Southeast Asia faces the highest incidence, as noted in the *British Medical Journal* [6]. Although the COVID-19 pandemic briefly disrupted this pattern, the strong resurgence of infections in its aftermath underscores the enduring and formidable threat of dengue across the region [7].

A *Nature* journal study suggest that nearly three out of every five people could face the threat of dengue by 2080 [8]. Also, the World Health Organization warns that dengue alone sparks up to 400 million infections each year [9], casting its shadow over almost half of humanity [10]. Over the past five decades, this mosquito-borne menace has surged alarmingly, its prevalence rising thirtyfold, with one in five severe cases proving fatal [11]. In 2024, the disease leapt to unprecedented heights, infecting over fourteen million people worldwide [12]—double the tally of the previous year [13] and twelve times greater than a decade earlier [12].

Evolving Epidemiology of Dengue in Bangladesh

Since 2000, Bangladesh has experienced annual dengue outbreaks, with epidemics intensifying markedly in recent years. Dengue is now endemic across the country, with cases reported throughout the year. Incidence typically peaks between September and November, following the monsoon season. Historically, dengue cases in Bangladesh have been concentrated in the three largest cities—Dhaka, Chittagong, and Khulna. Between 2014 and 2016, fewer than 5% of individuals in the northern region showed evidence of prior dengue infection, compared with over 80% in Dhaka and Chittagong. Dengue fever in Bangladesh disproportionately affects young and middle-aged adults, is more prevalent among males in terms of total cases but results in a higher case fatality rate among females and older adults, and remains predominantly an urban phenomenon, with Dhaka City serving as the principal hotspot (**Figure 1**).

Demographic Distribution of Dengue in Bangladesh, 2023 and 2025

Between 2023 and 2025, dengue in Bangladesh under-went a striking demographic shift, evolving from a disease that predominantly affected older adults and women to one increasingly concentrated among men and younger populations. The 2023 outbreak proved particularly severe, with women accounting for 57% of deaths compared with 43% among men [14]. By late

2025, however, this pattern had reversed: as of 29 October, men represented nearly 60% of infections and the majority (53%) of fatalities [15], highlighting a transformation in the country's dengue burden.

DGHS data from September 2025 indicated that delayed hospital admission and co-morbidities such as diabetes and hypertension were key contributors to poor outcomes, particularly among the elderly [16]. Although total cases in 2025 exceeded those of the previous year, deaths fell by more than half, reaching 275 by October [17]. Hospitalizations, however, surged dramatically, quadrupling from June to October [15, 18]. During the course of this article's submission (18.11.2025), the death toll had risen to 343 and the caseload to 86,924 for the year. Most importantly, more than 900 patients were admitted with viral fever within a 24-hour period, while nearly 3,000 dengue patients were already receiving treatment across the country.

Across both years, dengue continued to weigh heavily on the young. Children and adolescents under 20 accounted for nearly a third of all cases in 2023, their vulnerability linked to higher hemoglobin levels and developing immune systems. By 2025, young adults aged 21–30 had become the most affected group, their increased mobility and workforce participation likely amplifying exposure to mosquito vectors [17, 19]. Alarmingly, of the 307 deaths reported by early November 2025, more than half were among young people.

Contested Epidemiological Claims and the Perils of Unverified Reporting

Regrettably, a scientist from ICDDR, B asserted that in 2023, nearly two-thirds (66%) of dengue infections occurred outside Dhaka, despite the city having accounted for almost two-thirds (63%) of cases in 2022 [19]. This statement directly contradicts findings from the September 2023 report by ACAPS, a Swiss-based NGO, which indicated that nearly 45% of cases and about 70% of deaths occurred in Dhaka by mid-September [20]. It also conflicts with the analysis of Assaduzzaman et al. (2025), who, using data from the Management Information System of the Ministry of Health and Family Welfare, confirmed that over half of all cases and nearly four out of five deaths were concentrated in Dhaka city [14]. Sorrowfully, The Guardian published the scientist's remarks without verifying the accuracy of his claims [19].

Environmental And Climatic Drivers

The recent dengue outbreaks, driven by shifting climate patterns, rapid urbanization, dense populations, insecticide resistance, and low public awareness, have severely strained Bangladesh's healthcare system and economy. While climate change greatly influences dengue (Flavivirus) transmission, insecticide misuse and growing resistance also play critical roles [21]. Experts warn that prolonged monsoons and poor waste management have created stagnant water and ecological imbalance, enabling mosquitoes to breed more extensively and intensifying the outbreaks [22].

Warmer temperatures accelerate mosquito aging, reducing their lifespan and altering infection patterns [23]. Yet, over generations, heat-exposed mosquitoes evolve greater virus tolerance without losing vitality, a recent study finds [24]. Global warming has become a "perfect storm" for mosquito-borne diseases, influencing every stage of transmission [25].

Although many attributed the 2025 outbreak to heavy rainfall, the persistence of dengue had already been evident, with over 320,000 infections and 1,700 deaths recorded in 2023—figures considerably higher than those observed in 2025 [26]. Interestingly, a study conducted in Dhaka revealed that dengue cases actually declined with increasing levels of both rainfall and sunshine, contradicting common public perception [27].

Urbanization, Vegetation Loss, and Rising Temperature

The loss of natural vegetation driven by urbanization elevates the risk of dengue, as regions with diminished green cover offer favorable conditions for mosquito breeding and disease proliferation, as evidenced by studies in Mexico [28] and Brazil [29]. In Amazonian Brazil, for instance, deforestation of just one square kilometer was associated with 27 additional malaria cases [30].

Between 1989 and 2020, Dhaka lost over half its green cover to rapid urban growth, triggering a marked temperature rise [31]. Over three decades, extreme heat days (≥35°C) nearly doubled, making Dhaka one of the world's fastest-warming cities, according to the International Institute for Environment and Development [32]. Moreover, the World Bank reports the city's heat index grew over 65% faster than the national average [33]. Consequently, Dhaka accounted for over 80% of Bangladesh's dengue cases in 2019 [34] and nearly two-thirds of related deaths in 2022 [29]. Between January and October 28 of this year, Dhaka reported just over one-quarter of all dengue infections nationwide — yet continued to bear a disproportionate toll, with nearly two-thirds of the fatalities occurring within the city [35].

Urban Density, Poor Sanitation, and Waste Disposal

In Bangladesh, rapid urbanization and high population density are combining to create the perfect conditions for increased dengue transmission. The overcrowded city landscapes, often poorly serviced by sanitation infrastructure, result in stagnant water that serves as abundant breeding ground for *Aedes* mosquitoes. Moreover, in many dense urban neighborhoods, inconsistent water supply forces residents to store water in containers—an issue well documented in neighboring India—that further compounds the risk of mosquito proliferation [36, 37].

In capital Dhaka, densely populated residential and mixed-use areas drive dengue incidence by providing abundant breeding sites and increasing human–mosquito contact, with hotspots forming where population density is highest, especially in Badda, Jatrabari, kadamtali, Mirpur, Mohammadpur, Sobujbagh, Shyampur, Tejgoan, Dhanmondi and Uttara [38].

Poor waste management is a critical driver of dengue risk among both children and adults—and in urban Bangladesh this threat looms large. Shockingly, 55% of solid waste in urban areas remains uncollected, creating ideal breeding grounds for the mosquitoes that spread the disease [39]. Evidence from urban Thiruvanathapuram, South India, indicates that inadequate waste management infrastructure can be associated with a 40% higher incidence of dengue and chikungunya cases [40]. Likewise, studies in informal urban settlements in Indonesia and Fiji reported that by age 4–5, over half of children had already been infected, highlighting how insufficient waste disposal accelerates early exposure to dengue [41].

Each day, some 230 tons of fecal waste pour into Dhaka's drains and canals, intensifying both environmental pollution and public health hazards [42]. Also, communities without proper toilet facilities, especially in crowded urban slums, are particularly vulnerable to mosquito-borne illnesses such as dengue and chikungunya [43]. Poor sanitation, coupled with the widespread practice of open defecation, creates unhygienic surroundings that nurture the breeding of disease-carrying mosquitoes.

Pollution as a Trigger for viral resistance and mosquito dynamics

In Bangladesh, dengue peaks from June to October, rising with temperature, humidity, and rainfall, but falling with wind and surface pressure [44]. The WHO estimates that nearly a quarter of human diseases and deaths result from long-term exposure to pollution [45]. Although research on environmental impacts on dengue in Bangladesh is limited, international studies highlight their importance. In fact, recent studies from Taiwan [46], Singapore [47], Guangzhou [48], and Greater São Paulo [49] show that air pollution—such as particulate matter (PM10, SO2, CO, NOs etc.) along with climate factors—affect mosquito populations, viral activity, and human immunity towards the virus.

A *Lancet* study cited that improperly discarded plastics collect stagnant water, providing ideal breeding habitats for *Aedes* mosquitoes that transmit dengue, Zika, chikungunya, and yellow fever, thereby directly increasing vector populations. Indirectly, plastic debris clogs drainage systems, creating larger stagnant pools that promote mosquito proliferation and elevate the risk of diseases like malaria [50].

Bangladesh faces an alarming surge in micro plastic pollution, with the Meghna, Karnaphuli, and Rupsha Rivers together discharging nearly one million metric tons of mismanaged plastic each year. Per capita plastic consumption has tripled to 9 kg from 2005 to 2020, while the COVID-19 pandemic alone produced over 78,000 tons of additional polythene waste [51]. Beyond environmental harm, this growing plastic burden may intensify mosquito-borne diseases: research shows that mosquitoes exposed to micro plastics can transmit them to mammals, experience altered gut microbiomes, delayed development, and reduced insecticide susceptibility—factors that could heighten disease transmission risks [52].

Construction Sites and High-Rises: Major Breeding Grounds Driving Dengue in Dhaka

Dhaka's rapid and largely unplanned urban expansion has transformed the city into a highly conducive environment for *Aedes* mosquito proliferation. Numerous under-construction buildings, left exposed to the elements, now serve as prime breeding grounds for the vectors of dengue. Surveys indicate that, in the decade preceding 2016, an average of 95,000 new structures were erected annually within the jurisdiction of the Rajdhani Unnayan Kartripakkha (RAJUK). Over the subsequent fifteen years, at least 64,000 additional buildings were constructed across the capital [53, 54]. In July 2020, inspections conducted by the Dhaka North City Corporation (DNCC) revealed that nearly 70% (8,764 out of 12,619) of homes and construction sites surveyed across 55 wards harbored potential *Aedes* breeding sources [55]. These inspections were carried out in collaboration with the National Malaria Elimination and *Aedes* Transmitted Disease Control Programme under the Directorate General of Health Services (DGHS).

The following year, the situation deteriorated further. A 2021 DGHS study covering 70 areas of Dhaka reported alarming *Aedes* densities, with the Breteau Index (BI)—the number of water-holding containers infested with larvae per 100 houses—rising to 23.3 in Lalmatia and Iqbal Road (Ward 32, DNCC) and 20.0 in Saidabad and Uttar Jatrabari (Ward 48, DSCC). High-rise buildings accounted for over 45% of breeding sites, followed by under-construction structures at nearly 35% [56]. In 2024, the former Mayor of DSCC warned that construction would be halted wherever *Aedes* larvae were detected and that dengue control drives would be launched in advance of the rainy season, alongside the government's seven-year National Dengue Prevention and Control Strategy [57]. The most recent pre-monsoon survey, conducted jointly by the DGHS Communicable Disease Control Programme and the Institute of Epidemiology, Disease Control and Research (IEDCR), presents a similarly concerning picture: multistory buildings accounted for almost 60% of *Aedes* larvae, with a further 20% found in under-construction sites [58].

From Neglect to Epidemic: How Policy Failures Worsened Dengue in Bangladesh

Bangladesh's authorities have repeatedly failed to curb *Aedes* populations, relying on outdated chemical methods while neglecting root causes and community-level interventions. Government responses have remained fragmented. In 2023, authorities were unable to control *Aedes* mosquitoes, instead blaming households and imposing unethical fines. Mismanagement and flawed strategies have allowed dengue to spread unchecked, rendering prevention efforts largely symbolic. Transparency International Bangladesh identified key causes of high mortality, including insufficient hospital staff, delayed diagnoses, false-negative NS1 tests, weak vector control, and limited healthcare facilities outside Dhaka [59]. Experts have warned that the absence of strategic planning, adherence to WHO guidelines, and engagement of qualified professionals has further intensified Bangladesh's dengue crisis. In 2024, South Asia endured its most severe dengue epidemic on record, with Bangladesh and India reporting thousands of deaths as hospitals became inundated. In FY 2024–25, Dhaka South City Corporation expended less than 40% of its overall budget, despite increasing the allocation for mosquito control by 19 % [60]. Also, the two Dhaka city corporations spent more than BDT 1,000 crore (over $80 million) on mosquito-control programs and insecticide purchases, an expenditure that was effectively wasted. Weak implementation, poor coordination, outdated strategies, and shortages of chemicals and manpower severely undermined larviciding, mosquito control, and drain-cleaning operations.

Conclusion

In Bangladesh, the combination of rising temperatures, unplanned urban growth, and worsening pollution has created an ideal environment for mosquitoes, turning the country's rapid development into a relentless struggle against its deadliest tiny predator. The persistent and evolving threat of dengue highlights the urgent need for timely hospitalization, as the disease can progress rapidly, alongside systematic research to understand how environmental pollution, climate variability, and widespread pesticide use are influencing viral resistance and mosquito dynamics. Media coverage has largely failed to convey the severity of the situation, and domestic research remains limited, often attributing outbreaks solely to erratic rainfall, monsoon shifts, and stagnant water. Yet studies from regions with similar dengue patterns point to overlooked factors, including air pollution, pesticide and micro plastic resistance, and the complex interactions between urbanization and mosquito ecology. With low health literacy, even robust research seldom translates into public awareness or policy action, and progress in evidence-based studies remains slow. Coordinated efforts that integrate early clinical care with rigorous scientific investigation are therefore essential to reduce the growing public health burden of dengue.

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