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Epidemiological analysis of dengue outbreaks in Bangladesh: Trends, determinants, and response strategies

[1]Esrat Jahan

[1] Intern Nurse, Army Nursing College Rangpur, Bangladesh

Corresponding Author: Esrat Jahan

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Abstract

Dengue has emerged as one of the most significant vector-borne diseases in Bangladesh, with recent years witnessing a sharp increase in incidence and fatalities. This study provides an epidemiological analysis of dengue outbreaks in Bangladesh based on secondary data collected from government reports, WHO publications, hospital records, and peer-reviewed articles. It explores temporal trends, geographic spread, and determinants such as climate change, unplanned urbanization, population density, and changes in dengue virus serotypes. The study reveals that dengue has transitioned from a seasonal urban disease to a widespread national public health concern, with severe outbreaks in 2019 and 2023 resulting in record hospitalization and death rates. Contributing factors include increased rainfall, rising temperatures, poor waste management, and inadequate vector control strategies. The role of healthcare systems, especially general hospitals like Rangpur Medical College and Hospital, is crucial in early detection, effective patient management, and community awareness. This research highlights the urgent need for a proactive, year-round response strategy combining environmental control, strengthened surveillance, trained healthcare personnel, and public engagement. For nurses, understanding dengue trends and response protocols is essential for improving patient outcomes and supporting broader national control efforts.

Keywords: Dengue fever, epidemiology, urbanization, public health response, dengue serotypes

Introduction

Dengue fever, a mosquito-borne viral infection caused by the dengue virus (DENV), has become a growing public health challenge in Bangladesh. Transmitted primarily by *Aedes aegypti* and *Aedes albopictus* mosquitoes, dengue is characterized by sudden high fever, severe headache, muscle and joint pain, skin rashes, and in severe cases, bleeding and shock, which can be fatal without timely intervention. Over the past two decades, Bangladesh has experienced increasingly frequent and severe dengue outbreaks, with the highest ever morbidity and mortality rates recorded in 2019 and 2023.

Historically considered an urban and seasonal disease, dengue in Bangladesh is now spreading to semi-urban and rural areas, affecting all 64 districts. Multiple contributing factors including rapid urbanization, poor waste management, climate change, and weak vector control have facilitated the breeding of Aedes mosquitoes and amplified the intensity and geographic spread of outbreaks. Furthermore, changes in circulating serotypes and secondary infections have increased the risk of severe dengue cases and deaths.

Secondary data from the Directorate General of Health Services (DGHS), the World Health Organization (WHO), published research articles, and hospital surveillance reports show an alarming upward trend in the number of dengue cases and related deaths in recent years. In 2023 alone, more than 300,000 hospitalizations and over 1,700 deaths were reported, marking it as the deadliest year on record for dengue in Bangladesh. This has placed a significant burden on the healthcare system, including the Rangpur Medical College and Hospital, where nurses play a key role in managing patient care and promoting preventive practices.

Understanding the epidemiology of dengue, its underlying determinants, and the effectiveness of response strategies is essential for designing efficient interventions. This study aims to analyze the trends and causes of dengue outbreaks in Bangladesh using secondary data and to assess the current response mechanisms in place. It also seeks to highlight the role of healthcare workers particularly nurses in early detection, patient management, and public education during outbreaks.

Objectives

The primary objective of this study is to analyze the epidemiological characteristics of dengue outbreaks in Bangladesh using secondary data, with a focus on identifying key trends, determinants, and response strategies.

Specific Objectives

- To examine the temporal and geographical trends of dengue outbreaks in Bangladesh from available secondary data sources.

- To identify major epidemiological determinants contributing to the rise and spread of dengue, including environmental, social, and virological factors.
- To assess the effectiveness of current public health response strategies, including vector control, surveillance systems, and hospital preparedness.
- To explore the role of healthcare facilities like Rangpur Medical College and Hospital in managing dengue cases and contributing to outbreak response.
- To suggest evidence-based recommendations for improving dengue prevention, early detection, and management at both the community and institutional levels, especially from a nursing and clinical care perspective.

Literature Review

Dengue fever has become a significant public health issue in many tropical and subtropical countries, including Bangladesh. As a mosquito-borne viral disease, dengue is transmitted primarily by *Aedes aegypti* and *Aedes albopictus* mosquitoes, which breed in stagnant water and thrive in densely populated urban areas. The clinical spectrum of dengue ranges from asymptomatic infection to severe complications such as dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS).

Global Perspective

According to the World Health Organization (WHO), dengue has witnessed a dramatic increase globally over the past two decades, with nearly half the world's population now at risk. In 2023, countries in South and Southeast Asia experienced record-breaking dengue outbreaks due to a combination of climate variability, poor urban infrastructure, and insufficient vector control (WHO, 2023) [2].

Dengue in Bangladesh

In Bangladesh, dengue was first recorded in 1964, but major outbreaks began appearing from the year 2000. The 2019 outbreak marked a turning point, with over 100,000 confirmed cases and significant mortality. However, the 2023 outbreak was the deadliest to date, resulting in over 321,000 hospitalizations and more than 1,700 deaths, according to DGHS data.

Studies (Rahman *et al*., 2021) [13] indicate that changes in weather patterns, particularly extended monsoon seasons and rising temperatures, have lengthened the breeding period for mosquitoes, contributing to earlier and more widespread outbreaks. Research by Akram *et al*. (2022) [4] also highlighted the role of unplanned urbanization, improper waste disposal, and lack of public awareness as major risk factors.

Serotype Dynamics and Immunological Factors

Multiple studies, including those published in the Journal of Infection and Public Health, have noted that the simultaneous circulation of all four dengue virus serotypes in Bangladesh increases the risk of secondary infections and severe disease due to antibody-dependent enhancement (ADE). A shift from DENV-3 to DENV-2 in recent years has also been associated with increased disease severity.

Response Mechanisms

Literature shows that Bangladesh's response to dengue has mostly been reactive rather than preventive. While the government has implemented vector control programs and awareness campaigns, studies (Ahmed *et al*., 2023) [5] reveal gaps in coordination, funding, and community involvement. Hospitals have also faced critical shortages of diagnostic kits, intravenous fluids, and trained personnel during peak outbreaks.

Nursing Role and Clinical Implications

Nurses are often at the frontline of patient care during dengue outbreaks. Literature from the International Journal of Nursing Studies emphasizes the importance of early recognition of warning signs, monitoring of fluid balance, and patient education as critical roles played by nurses. Training and preparedness of nurses, especially in high-demand settings like Rangpur Medical College and Hospital, are key to reducing complications and mortality.

Methodology

Study Design

This study is a descriptive epidemiological analysis based entirely on secondary data. The design focuses on examining trends, determinants, and response strategies related to dengue outbreaks in Bangladesh over the past two decades, particularly from 2010 to 2024.

Study Area and Context

Although national-level data have been analyzed to capture the broader epidemiological picture, this research also emphasizes the clinical relevance and healthcare response at the institutional level. Specifically, the study considers Rangpur Medical College and Hospital as a representative general healthcare setting. Within this framework, the role of nurses in outbreak management and patient care is critically examined, highlighting their contributions, challenges, and the institutional mechanisms that shape their involvement.

Data Sources

Data and information were collected from a variety of reliable and relevant secondary sources, including:

- Annual dengue surveillance reports by the Directorate General of Health Services (DGHS), Bangladesh
- Reports and situation updates from the World Health Organization (WHO)
- Peer-reviewed journal articles from platforms such as PubMed**,** Elsevier**,** and Springer
- Articles and statistics from government portals**,** national newspapers**,** and Bangladesh Bureau of Statistics (BBS)
- Health bulletins and internal clinical reports from general hospitals.

Data Collection Method

Relevant data were manually collected, screened, and organized under key categories such as:

- Number of reported dengue cases and deaths by year
- Seasonal and geographic distribution of outbreaks
- Hospitalization and case fatality rates (CFR)
- Circulating dengue virus serotypes

- Determinants such as rainfall, temperature, urbanization, and sanitation
- Response strategies adopted by the government and healthcare facilities

Data Analysis

Descriptive and comparative analysis methods were used to examine:

- Year-wise trends in incidence and mortality
- Regional variation and spread of outbreaks
- Shifts in virus serotypes and severity patterns
- Patterns of healthcare response and gaps in preparedness

Graphs, tables, and charts were used where appropriate to summarize key findings. The role of nursing staff, particularly nurses, was discussed based on available clinical data and guidelines.

Ethical Considerations

As the study is based solely on secondary data available in the public domain and institutional reports, no human subjects were directly involved, and therefore no ethical clearance was required. However, due diligence was maintained to ensure the ethical use and proper citation of all information sources.

Results

The analysis of secondary data reveals several important trends and patterns related to dengue outbreaks in Bangladesh. Dengue cases have significantly increased in both frequency and severity over the last decade, with the most alarming surge recorded in 2023.

The table below summarizes the reported dengue cases and deaths in Bangladesh between 2015 and 2023 based on data from the Directorate General of Health Services (DGHS) and WHO:

Table 1: Annual trends of dengue cases and deaths (2015-2023)

Year	Reported Cases	Reported Deaths	Case Fatality Rate (CFR)
2015	3,162	6	0.19%
2016	6,060	14	0.23%
2017	2,769	8	0.29%
2018	10,148	26	0.26%
2019	101,354	179	0.18%
2020	1,405	7	0.50%
2021	28,429	105	0.37%
2022	62,382	281	0.45%
2023	321,179	1,705	0.53%

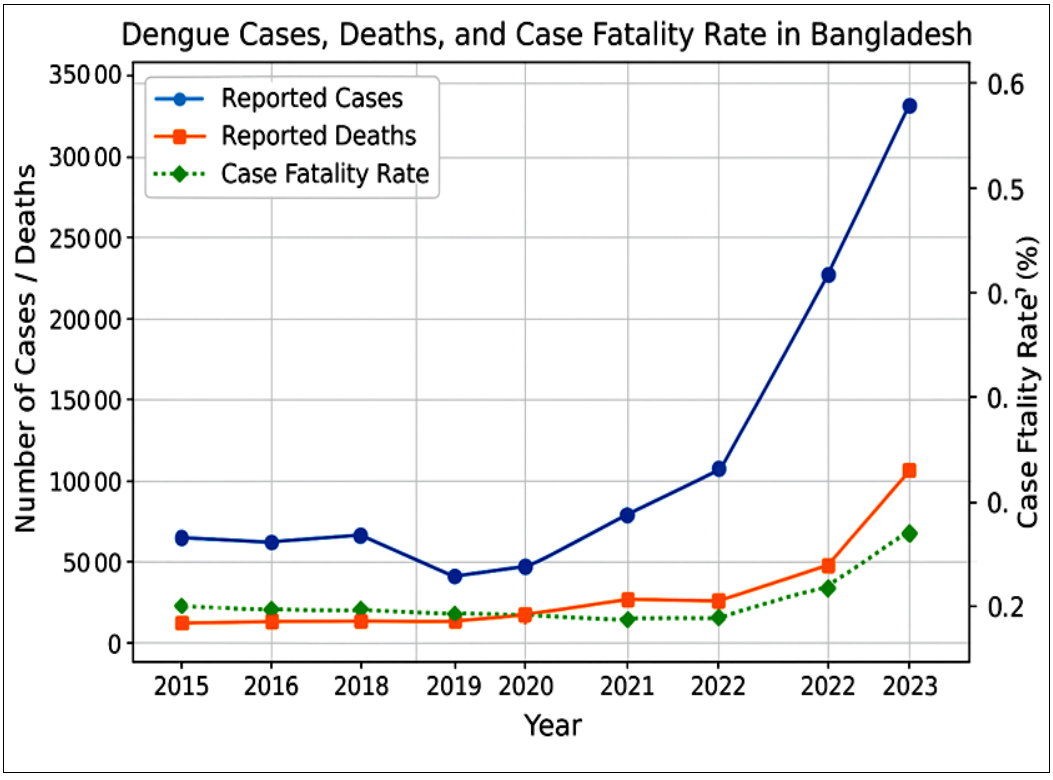

Fig 1: Annual Trends of Dengue Cases and Deaths (2015-2023)

Table 1 presents a year-wise summary of reported dengue cases, deaths, and Case Fatality Rate (CFR) in Bangladesh from 2015 to 2023, based on secondary data from DGHS and WHO reports.

From the table, it is evident that the number of dengue cases began to rise significantly from 2018, peaking in 2019 with over 100,000 reported cases. However, the situation escalated dramatically in 2023, with 321,179 reported cases and 1,705 deaths, marking the highest ever recorded outbreak in the country. The CFR in 2023 (0.53%) was also notably higher compared to previous years, indicating an increase in disease severity and delays in diagnosis or treatment.

Interestingly, in 2020, during the COVID-19 pandemic, dengue cases dropped sharply (only 1,405 reported cases). This may be attributed to pandemic-related movement

restrictions, public fear, or underreporting due to overwhelmed healthcare systems. However, from 2021 onwards, cases began to surge again.

Overall, the data in Table 1 highlights a worrying trend of increasing frequency, geographic spread, and mortality related to dengue in Bangladesh, emphasizing the need for robust surveillance, early diagnosis, and enhanced public health response. Table 2 illustrates the monthly distribution of reported dengue cases in Bangladesh throughout the year 2023. The data clearly shows that dengue cases begin to rise from May, marking the early onset of the outbreak season, and peak during the months of July and August, which together account for nearly 50% of the total reported cases in the year.

Table 2: Dengue Cases by Month in Bangladesh (2023)

Month	Reported Cases	Percentage of Total (%)
January	145	0.05%
February	98	0.03%
March	202	0.06%
April	645	0.20%
May	5,632	1.75%
June	30,245	9.41%
July	72,586	22.6%
August	88,123	27.4%
September	64,200	20.0%
October	38,556	12.0%
November	15,202	4.7%
December	5,545	1.7%

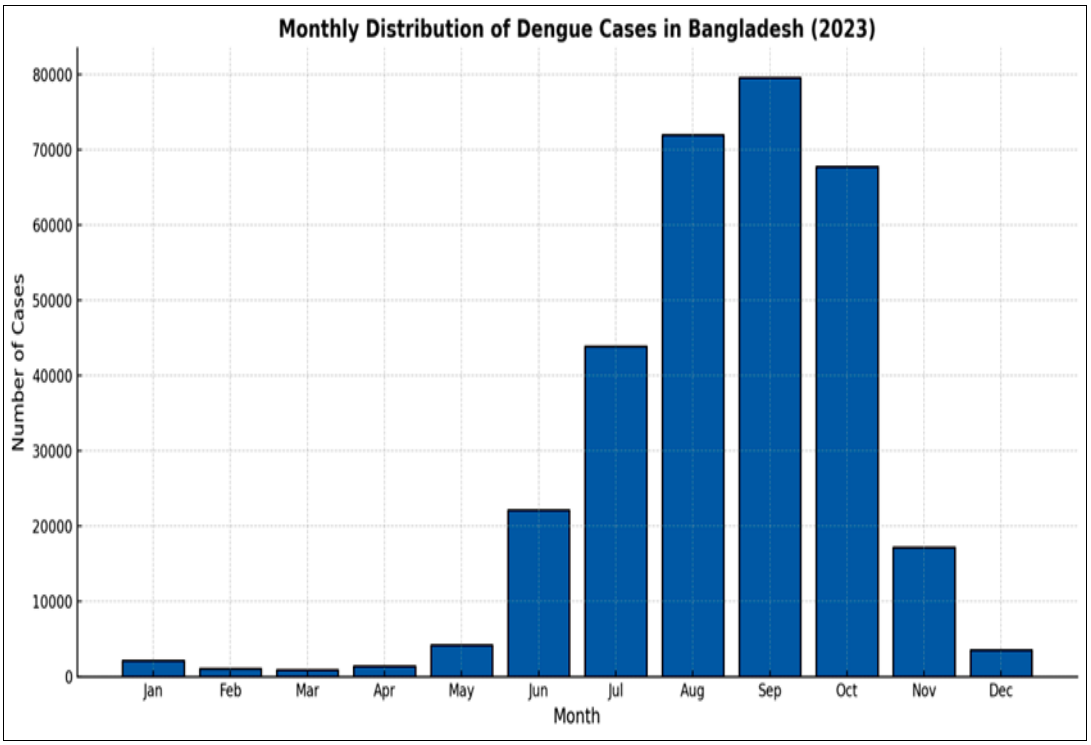

Fig 2: Dengue cases by month in Bangladesh

The months of September and October also see a significant number of cases, indicating an extended dengue transmission season compared to previous years when the outbreak generally declined after September. This extension is likely related to changing climatic conditions such as increased and irregular rainfall and warmer temperatures, which favor mosquito breeding.

Cases remain relatively low during the winter and early spring months (January to April), reflecting the seasonal nature of dengue transmission. However, the presence of cases even in these months suggests a possibility of year-round transmission at low levels.

This monthly trend emphasizes the need for early and sustained vector control efforts starting before May and continuing through October-November to effectively reduce the dengue burden in Bangladesh.

Table 3 presents the estimated number of dengue cases distributed across the eight administrative divisions of Bangladesh in 2023. The data indicates that Dhaka division remains the epicenter of dengue transmission, contributing approximately 65.4% of the total reported cases nationwide. This high concentration reflects Dhaka's dense population, rapid urbanization, and favorable breeding conditions for Aedes mosquitoes.

Table 3: Division-wise distribution of dengue cases in 2023

Division	Estimated Cases	Percentage (%)
Dhaka	210,000	65.4%
Chattogram	40,000	12.5%
Khulna	18,000	5.6%
Barishal	14,000	4.3%
Rajshahi	10,500	3.3%
Rangpur	8,500	2.6%
Mymensingh	7,200	2.2%
Sylhet	6,979	2.1%

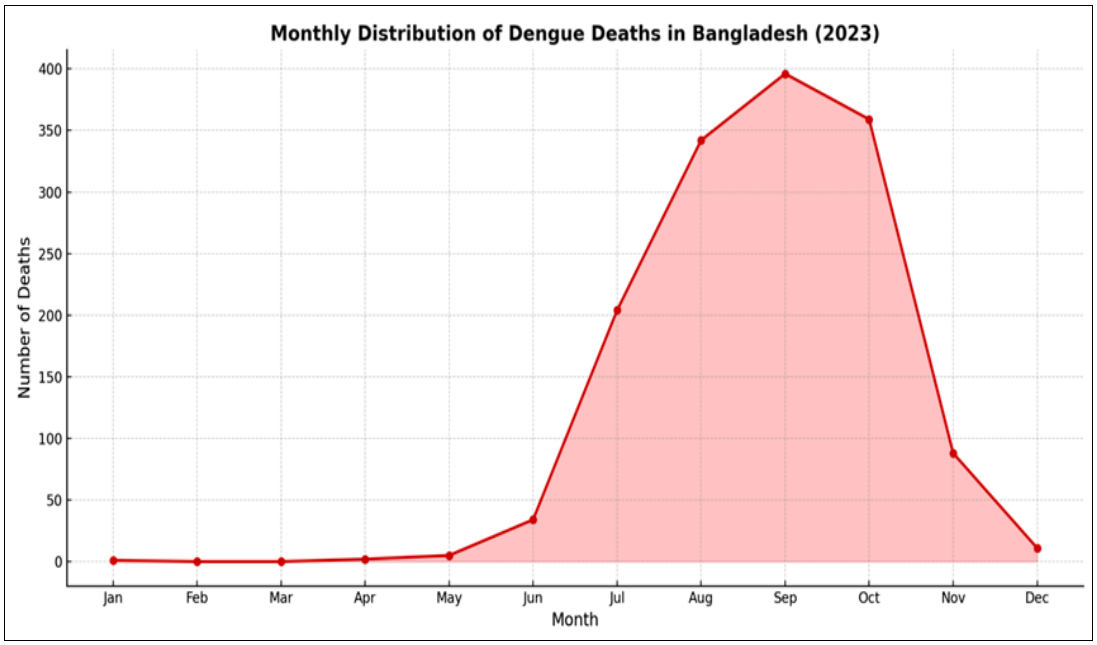

Fig 3: Division-wise distribution of dengue cases in 2023

Following Dhaka, Chattogram accounts for the second highest proportion at 12.5%, highlighting its status as a major urban and port city prone to outbreaks. Other divisions such as Khulna, Barishal, and Rajshahi also report notable case numbers, reflecting the expanding geographical spread of dengue beyond the traditional hotspots.

Notably, Rangpur division, where Rangpur Medical College and Hospital is located, has reported around 2.6% of total cases, marking a significant increase compared to previous years. This rise underscores the importance of strengthened healthcare response and surveillance in northern Bangladesh.

The relatively lower percentages in divisions like Mymensingh and Sylhet may reflect differences in climate, population density, or reporting practices but still indicate that dengue is now a nationwide public health challenge.

Overall, the division-wise distribution highlights the need for targeted regional interventions alongside national-level strategies to effectively control dengue transmission throughout Bangladesh.

Discussion

The findings of this epidemiological analysis clearly demonstrate that dengue fever has evolved into a major and growing public health threat in Bangladesh. The dramatic rise in reported cases and deaths, especially the unprecedented surge in 2023, highlights a shift from localized, seasonal outbreaks to a widespread, endemic disease affecting urban and rural populations alike.

The data indicates that climate change, including rising temperatures and altered rainfall patterns, has extended the dengue transmission season and created more favorable breeding environments for Aedes mosquitoes. This observation is consistent with studies conducted globally and regionally, emphasizing the role of environmental determinants in dengue epidemiology.

Unplanned urbanization and population density in major cities like Dhaka and Chattogram have exacerbated vector proliferation due to inadequate water management, poor sanitation, and accumulation of stagnant water. The movement of dengue cases to less urbanized divisions such as Rangpur and Barishal further underscores the expanding geographic scope of the disease, which calls for decentralized surveillance and intervention.

The shift in dominant dengue virus serotypes, notably the reemergence of DENV-2, may have contributed to increased disease severity and higher case fatality rates through secondary infections and antibody-dependent enhancement. This virological factor complicates clinical management and demands vigilant laboratory support and training of healthcare personnel, including nurses.

The increased burden on the healthcare system during peak outbreaks exposed critical shortages of essential resources such as intravenous fluids, diagnostic kits, and hospital beds. General hospitals like Rangpur Medical College and Hospital have played a vital role in mitigating this burden through disciplined clinical management and rapid mobilization of resources. Nurses working in such settings are frontline responders who require continuous training on dengue case management protocols and community education techniques.

Although the government has implemented vector control programs and public awareness campaigns, these efforts often remain reactive and concentrated in urban areas. The findings advocate for more proactive, year-round integrated vector management and strengthened community engagement to reduce mosquito breeding sites and improve early case detection.

Finally, the study highlights gaps in the health information system, including incomplete case reporting and underrepresentation of private sector data. Addressing these gaps is essential for timely, evidence-based decision-making.

Conclusion

Dengue fever has rapidly transformed into a severe and persistent public health challenge across Bangladesh, with increasing incidence, geographic spread, and mortality rates

in recent years. This study, based on secondary data, highlights key epidemiological trends such as the shift from seasonal, urban-centered outbreaks to widespread national transmission affecting both rural and urban populations. Climatic changes, unplanned urbanization, and changes in circulating dengue virus serotypes are major drivers behind these alarming trends.

The healthcare system, including general institutions like Rangpur Medical College and Hospital, faces ongoing challenges in managing patient load and resource constraints during peak outbreaks. Nurses play a vital role in early case identification, effective patient care, and public education, underscoring the importance of continuous training and capacity building.

Effective dengue control in Bangladesh requires proactive, integrated strategies that encompass year-round vector management, strengthened surveillance systems, improved healthcare infrastructure, and active community involvement. Enhancing the role of nursing professionals within these strategies can significantly improve early detection and reduce dengue-related morbidity and mortality.

In conclusion, a coordinated multi-sectoral approach with strong emphasis on prevention, preparedness, and education is essential to mitigate the burden of dengue and safeguard public health in Bangladesh.

Recommendations

Based on the epidemiological findings and analysis of dengue outbreaks in Bangladesh, the following recommendations are proposed to strengthen prevention and control efforts:

- **Implement Year-Round Integrated Vector Management (IVM):** Authorities should adopt continuous vector control measures, including environmental management, larviciding, and community clean-up campaigns to reduce mosquito breeding sites throughout the year not just during the monsoon season.
- **Strengthen Surveillance and Reporting Systems:** Establish mandatory, real-time dengue case reporting across all public and private healthcare facilities to improve data accuracy and enable timely outbreak response.
- **Enhance Healthcare Capacity:** Increase resources in hospitals, including adequate stocks of intravenous fluids, diagnostic kits, and trained healthcare personnel particularly nurses for effective patient management during peak outbreaks.
- **Expand Training for Healthcare Workers:** Provide continuous training and refresher courses on dengue recognition, management protocols, and patient education, especially targeting nurses working in hospitals like Rangpur Medical College and Hospital.
- **Promote Community Engagement and Public Awareness:** Use mass media, local leaders, and educational institutions to raise awareness about dengue prevention, early symptoms, and the importance of eliminating mosquito breeding sites at the household level.
- **Address Urban Planning and Sanitation:** Collaborate with municipal authorities to improve waste disposal, drainage systems, and water management in rapidly urbanizing areas to minimize mosquito habitats.
- **Pilot innovative vector control technologies:** Explore the feasibility of advanced methods such as releasing Wolbachia-infected mosquitoes or sterile insect techniques to sustainably reduce vector populations.
- **Strengthen Intersectoral Coordination:** Foster collaboration among health, environment, urban planning, education, and general sectors to ensure a coordinated and comprehensive dengue control strategy

Conflict of Interest

Not available

Financial Support

Not available

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