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Dengue Transmission in Bangladesh: A Retrospective Analysis of Case Trends and Mortality

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Abstract

Dengue virus remains a critical public health challenge in Bangladesh, with widespread prevalence contributing substantially to morbidity and mortality. Seasonal control of mosquito breeding is an essential strategy to prevent outbreaks. This study assesses dengue prevalence in 2022, contrasting it with data from previous years to identify peak transmission periods. Monthly case reports from the Bangladesh Institute of Epidemiology, Disease Control, and Research (2010-2022) revealed 51,089 confirmed dengue cases and 254 deaths in 2022, marking the highest annual mortality since 2000. Strikingly, 31.14% of all dengue-related deaths recorded since 2000 occurred in 2022 alone, emphasizing the escalating threat. Our analysis further indicates that the latter half of the year carries the highest transmission risk, with Dhaka and Chittagong bearing the heaviest burden (mortality rates of 0.42% and 0.70%, respectively), underscoring the role of population density. The significant rise in daily cases in 2022 highlights an urgent need for immediate interventions by individuals and government authorities to control the epidemic and prevent further escalation. These interventions could include increased mosquito control measures, public health campaigns, and improved healthcare infrastructure. Collaboration among all stakeholders is vital in this fight against dengue.

Keywords

Dengue, Epidemic, Outbreaks, Climate, Vaccine, Treatment, Disease

1. Introduction

Dengue fever, caused by one of four dengue virus serotypes (DENV 1 - 4), is a mosquito-borne illness transmitted by infected Aedes mosquitoes [1]. It poses a significant risk to over half the world's population, particularly in urban and semi-urban regions within tropical and subtropical zones. Annually, more than 400 million dengue infections are reported, resulting in approximately 22,000 fatalities [2]-[4]. The severity of the disease ranges from a low-grade fever to more serious situations like Dengue Hemorrhagic Fever (DHF) or Dengue Shock Syndrome (DSS), which is marked by elevated vascular permeability and decreased platelet and white blood cell counts [5]. While often asymptomatic, dengue follows established endemic and epidemic transmission patterns globally [3]. It is difficult to effectively control dengue in tropical areas because year-round mild temperatures encourage mosquito reproduction and virus persistence. Combating outbreaks demands considerable resources, including extensive insecticide use and sufficient healthcare personnel for patient treatment [6]. Located in a tropical climate near the equator, Bangladesh and other Southeast Asian nations face similar dangers, as the country offers a favorable habitat for mosquitoes that spread dengue and increase the likelihood of transmission [7]. Dengue has a significant financial impact on Bangladesh's healthcare system, as observed in other low- and middle-income countries, according to the Bangladesh National Health Accounts (BNHA-V) [8].

Between 2012 and 2019, Dhaka, Bangladesh's capital and most densely populated city with nearly 16 million residents, recorded the highest number of dengue cases [9]. According to research, a particular dengue virus (DENV) serotype infection confers lifetime immunity to that serotype; however, subsequent infections with other serotypes only provide temporary, partial protection and may raise the risk of severe dengue [10]. Dengue symptoms often mimic the common cold or flu, complicating diagnosis and treatment. The disease can cause liver damage by elevated liver enzyme levels [11], particularly severe cases have been associated with compromised heart function, such as diastolic and systolic failure brought on by injury to the right ventricular wall and septum [12]. Additionally, research links dengue to negative impacts on the kidneys, eyes, blood, brain, pancreas and endothelial cells [13]-[16]. Remarkably, every time a different serotype infects a person, the likelihood of developing a serious and possibly fatal illness rises [17]. While the precise mechanisms behind the virus-immune system interactions and the exacerbation of disease severity by prior immunity remain unclear, the necessity of a tetravalent dengue vaccine is apparent. To avoid heightened vulnerability, it must offer comprehensive immunity across all four serotypes [18]. Public awareness and preventive health practices are essential to reduce transmission [19], but limited awareness in Bangladesh leaves many at risk. Given the recent spike in dengue cases and deaths in Dhaka, enhancing and routinely evaluating local education, awareness, and prevention programs is increasingly critical.

Aedes aegypti mosquitoes carry the virus that causes dengue fever, which has become a major global health concern, especially in tropical and subtropical areas where mosquito breeding is common. Life-threatening illnesses, including hemorrhagic fever and shock syndrome, are among the symptoms, which also include high fever and excruciating muscle and joint pain, significantly elevating mortality risks. Over the past decade, dengue cases have surged, prompting health officials to track their seasonal and yearly trends for targeted interventions closely. Data from 2008 to 2022 illustrate a distinct seasonal pattern, with cases peaking during the monsoon season (July to October) when increased rainfall and humidity foster optimal mosquito breeding conditions. August and October consistently record the highest case numbers, while other months see minimal cases, underscoring the seasonal nature of dengue transmission.

Table 1 shows yearly analyses that highlight notable outbreaks, especially in 2019 and 2022. 2019 witnessed a record 109,680 cases, followed by 60,761 cases in 2022. These surges suggest potential links to climate change, urbanization, and inconsistencies in public health responses. The monthly case distribution reveals a pronounced seasonality, with cases rising from June to August, when nearly 30% of cases occur and remain high through October. August recorded extreme case numbers in 2019 (57,676 cases) and 2022 (3,921 cases), emphasizing the critical need for intensified vector control during this period. Cases decrease by November and drop sharply in December, aligning with more relaxed, drier conditions that are less favourable for mosquito breeding.

Annually, dengue cases vary, with outbreaks in some years, such as 2019, likely exacerbated by climate factors or gaps in vector control. Meanwhile, 2020 saw a

Table 1. Prevalence of cases by month, 2010-2022.

Month	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Cases	% Cases
January	0	0	0	3	19	0	19	52	27	33	198	92	156	599	0.28
February	0	0	0	9	5	0	9	98	9	21	87	17	28	283	0.05
March	0	0	0	4	5	4	19	86	21	19	72	19	21	270	0.04
April	0	0	0	7	0	7	88	43	59	87	52	8	26	377	0.15
May	0	0	0	19	9	16	89	194	42	123	16	49	193	753	0.30
June	0	69	20	51	10	29	294	297	285	1224	29	292	837	3437	1.78
July	65	251	149	192	92	131	726	236	986	17,233	73	2766	1971	24,871	12.57
August	184	631	172	359	90	795	1641	396	1716	57,676	98	7958	3921	75,637	29.87
September	140	163	296	395	86	935	1577	439	3987	19,286	67	7341	6611	41,323	17.14
October	35	174	197	504	61	829	1066	582	2486	8598	364	5928	16,932	37,756	20.92
November	0	46	28	268	32	291	542	489	1392	4033	596	3717	21,334	32,768	11.67
December	0	9	0	59	19	85	149	196	283	1347	291	1797	8731	12,966	5.23
Total	424	1343	862	1870	428	3122	6219	3108	11,293	109,680	1943	29,984	60,761	231,037	100

decline, possibly due to COVID-19 restrictions that inadvertently reduced transmission. The seasonal data confirms dengue's peak from July to October, with an exceptionally high incidence in August. These trends stress the need for year-round preventive measures, timely interventions, and sustained monitoring to manage dengue risks, particularly during high-risk months effectively.

With dengue fever now a recurring threat each monsoon season in Bangladesh, a thorough analysis of its incidence and mortality over the past two decades could enhance outbreak diagnosis and control measures. This study aims to provide a detailed overview of dengue prevalence and associated death rates, offering crucial insights into the ongoing dengue epidemic in Bangladesh.

2. Methods

Data from two important national organizations in Bangladesh were used in this study: the Institute of Epidemiology, Disease Control and Research (IEDCR) and the Directorate General of Health Services (DGHS), which is part of the Ministry of Health and Family Welfare. These organizations frequently post official press releases about confirmed dengue cases and associated deaths on the IEDCR website (https://www.iedcr.org/index.php?option=com_content&view=article&id=42&Itemid=99) and the DGHS portal (https://old.dghs.gov.bd/index.php/bd/). Comprehensive data on dengue incidence and mortality in the Bangladeshi population from January 1, 2000, to December 30, 2022, are compiled in Table 2, providing a detailed overview of the epidemic's development.

Table 2. Deaths and cases by year from 2000 to 2022.

Year	Cases	Death	Annual Mortality Rate (%) according to Verified Cases	% of Annual Deaths as a percentage of all deaths (837)
2000	5771	84	1.56	14.91
2001	2267	54	1.73	2.26
2002	6456	71	0.83	7.93
2003	576	19	3.06	2.24
2004	3796	18	0.43	2.61
2005	1456	9	0.48	0.52
2006	2600	22	0.60	2.25
2007	866	0	0.00	0.00
2008	1955	0	0.00	0.00
2009	972	0	0.00	0.00
2010	909	0	0.00	0.00
2011	1578	9	0.54	0.68
2012	691	3	0.27	0.25

Continued

2013	1459	1	0.19	0.17
2014	387	0	0.00	0.00
2015	3542	4	0.24	0.88
2016	5678	11	0.19	2.64
2017	2879	17	0.31	0.96
2018	10,568	26	0.33	6.11
2019	101,580	124	0.32	13.60
2020	1305	2	0.17	0.36
2021	28,229	112	0.45	10.49
2022	51,089	254	0.54	31.14
Total	236,609	855	12.24	100.00

3. Dengue Virus

3.1. Structure of *Aedes aegypti*

The Dengue virus, an enveloped virus within the *Flavivirus* genus, has a sophisticated structure that enhances its infectivity and pathogenicity. Its genome consists of a single-stranded RNA molecule about 10.7 kilobases long. It encodes several proteins critical for its life cycle, including the envelope (E) and membrane (M) proteins, both vital to the virus's ability to enter host cells [20]. The E protein facilitates viral attachment and fusion with host cell membranes, forming the virus's outermost layer. Meanwhile, the minor M protein, closely associated with the envelope, is essential for assembling and releasing new virions from infected cells. The viral envelope encloses the nucleocapsid, which contains the viral RNA and capsid protein; this nucleocapsid structure safeguards the genome and contributes to the virus's stability and infectivity (**Figure 1**). These work in concert, enabling the Dengue virus to infect, replicate, and spread efficiently within the host [21].

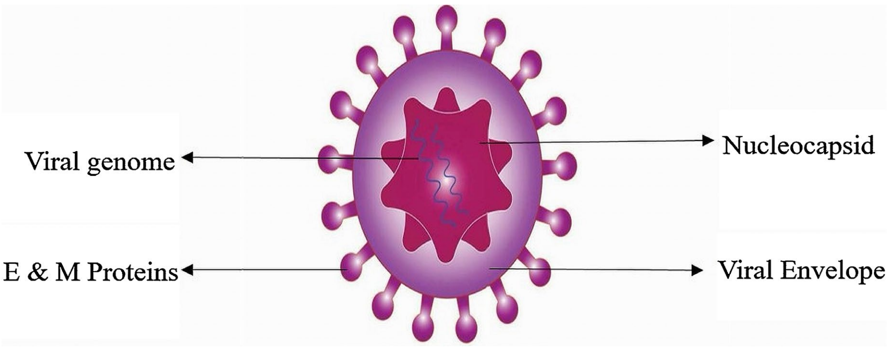

Figure 1. Structure of dengue virus.

3.2. Life Cycle of *Aedes aegypti*

The life cycle of *Aedes aegypti*, the primary vector for dengue fever, comprises four stages: egg, larva, pupa, and adult. Under favorable conditions, warm temperatures, and stagnant, clean water, this cycle can be completed in 7 to 14 days [22]. Understanding this life cycle is essential for creating strategies to control mosquito populations and reduce dengue transmission. The cycle begins when a female mosquito lays 100 to 200 eggs near standing water, often on container walls like buckets, flowerpots, or discarded tires. Remarkably resilient, these eggs can survive for months in dry conditions, hatching within 1 to 2 days once rehydrated [23]. After hatching, the larvae, known as "wrigglers", enter the second stage of development, where they thrive in water, feeding on organic matter, algae, and microorganisms. During this 5- to 7-day phase, the larvae undergo four molts or "instars", adapting to environmental factors such as temperature, food supply, and water quality [24]. This stage is characterized by the larvae's visible wriggling near the water's surface, making them identifiable and vulnerable to targeted control efforts.

Aedes aegypti transitions into the pupal stage following the larval stage, often called tumblers. Unlike larvae, pupae do not feed; this non-feeding stage is a crucial transitional phase where larvae undergo metamorphosis into adult mosquitoes. Lasting approximately 2 to 3 days, the pupal stage involves significant physiological changes, including the development of wings, legs, and reproductive organs (**Figure 2**). The pupae are more resilient than larvae due to a protective outer casing that safeguards them during this transformative period. Once fully developed, the adult mosquito emerges from the pupa, marking its entry into life outside the water.

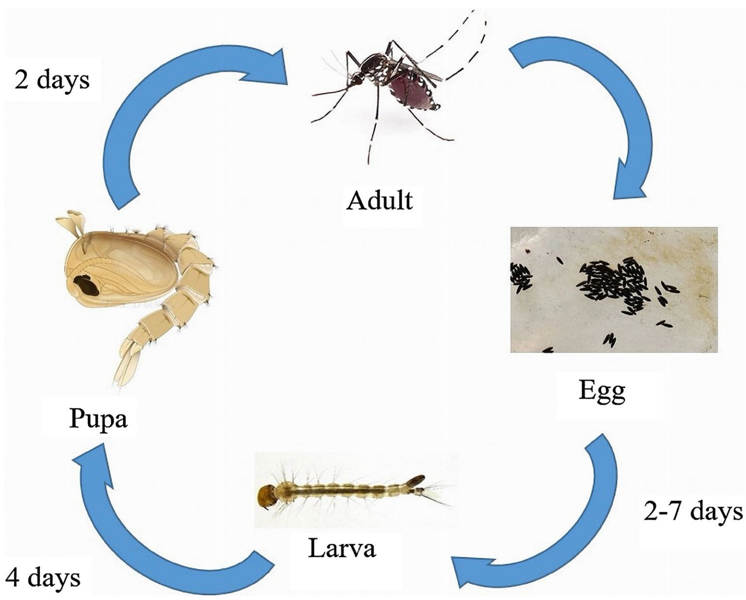

Figure 2. *Aedes aegypti* life cycle.

Adult *Aedes aegypti* mosquitoes measure about 4 to 10 millimeters in length and are easily identifiable by their distinct black and white markings on their legs and body [25]. After emerging, the adult must rest for several hours to allow its wings to dry and expand fully before flight. The lifespan of an adult *Aedes aegypti* can range from a few weeks to several months, influenced by environmental conditions, food availability, primarily nectar, and access to blood meal hosts, which are vital for females to produce eggs. While female mosquitoes require blood meals from various hosts, including humans, males do not need blood and primarily feed on nectar and plant juices. The rapid reproduction rate and adaptability of *Aedes aegypti* significantly contribute to the ongoing transmission of dengue fever. This swift life cycle emphasizes the need for effective vector control measures, such as eliminating standing water and employing insecticides, to manage mosquito populations and reduce the incidence of mosquito-borne diseases. By understanding this mosquito's life stages and environmental requirements, public health efforts can be strategically directed to prevent outbreaks and safeguard communities from the associated health threats.

3.3. Fever Spread

Aedes aegypti mosquitoes are the primary carriers of the dengue virus, which causes dengue fever, a viral infection. When an infected mosquito bites a human, the virus enters the bloodstream through the mosquito's saliva, starting the transmission cycle. The virus primarily targets white blood cells (WBCs) and lymphatic tissues once it has entered the human body. As a result, the virus multiplies, and the immune system reacts, causing dengue fever symptoms. The virus primarily replicates in two types of white blood cells (WBCs): monocytes and macrophages (**Figure 3**). These cells can cause inflammation and lead to symptoms like high fever, excruciating headaches, pain behind the eyes, and pain in the joints and muscles. The virus spreads throughout the body by disseminating through the lymphatic system. A mosquito can reproduce the dengue virus in its salivary glands after consuming blood containing the virus from an infected person. The normal duration of this replication process is 8 to 12 days. During this time, the mosquito becomes contagious and can bite other people to spread the virus [26]. When Aedes aegypti mosquitoes feed on the blood of dengue-infected patients, they become vectors

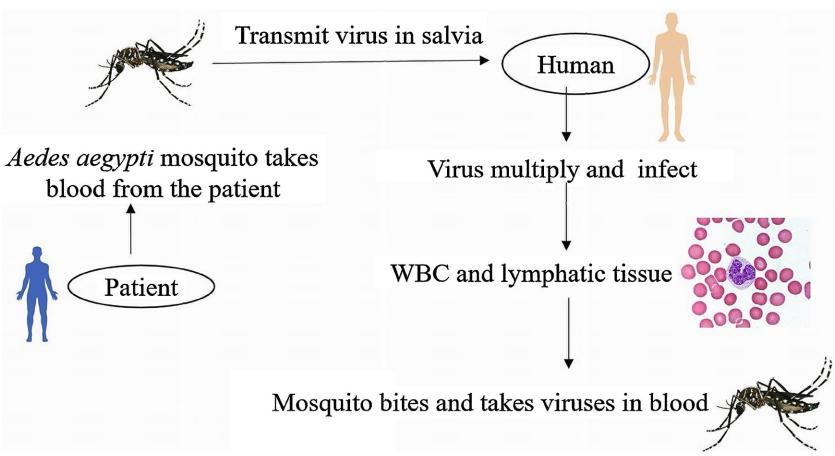

Figure 3. Dengue fever spread.

for the virus, continuing the cycle. If vulnerable people and Aedes aegypti mosquitoes coexist in the same environment, the dengue virus can continue to spread and cause outbreaks that present serious public health risks. Implementing efficient vector control measures to slow the spread of dengue disease requires understanding this transmission cycle.

3.4. Dengue Virus Transmission Mode

Aedes mosquito bites are the primary way that the dengue virus is spread, with *Aedes aegypti* serving as the most critical vector. The transmission cycle starts when a female mosquito bites an infected person, bringing the dengue virus into her body. The mosquito is looking for blood to produce her eggs. The virus grows inside the mosquito for eight to twelve days, especially in the salivary glands. The infection cycle can be continued by the virus spreading to additional people through repeated blood meals once it has entered the mosquito's saliva. The dengue virus primarily inhabits humans, which is essential to its life cycle. After an Aedes mosquito bite, the infected person may have various dengue fever symptoms, such as a high fever, excruciating headaches, joint and muscular pain, and rash. These symptoms usually appear 4 - 10 days after infection, a time known as the incubation period [27]. The risk of transmission to others increases when symptomatic individuals are present because they are more likely to be bitten by mosquitoes. In addition to mosquito-borne transmission, dengue can also spread through blood transfusions; if an infected donor's blood is transfused into a recipient, the virus can be introduced into the recipient's bloodstream, potentially leading to infection. This transmission mode is particularly concerning in endemic regions, highlighting the need for careful screening of blood donations to prevent outbreaks. While *Aedes aegypti* mosquitoes are the primary vectors, other animals, such as dogs and monkeys, can become infected with the virus; however, they are not considered significant reservoirs (**Figure 4**). These animals may play a minor role in the virus's ecology, supporting its presence in the environment without significantly contributing to human infections. Understanding the various modes of dengue virus transmission is essential for developing effective prevention and control strategies. Public health interventions aimed at reducing mosquito populations, educating communities about protective measures against mosquito bites, and ensuring safe blood transfusions can significantly mitigate the risk of dengue virus transmission and protect public health.

3.5. Human Body's Symptom

When a person is infected with the dengue virus transmitted by *Aedes aegypti* mosquitoes, symptoms typically manifest within 4 to 10 days after the initial bite [28]. This incubation period can vary among individuals, influenced by factors such as the virus strain, immune response, and overall health. The onset of dengue fever is often marked by a sudden high fever, which can spike to 104˚F (40˚C) or higher [29]. This fever is usually accompanied by debilitating, severe headaches and pain behind the eyes, a distinctive symptom differentiating dengue from other viral infections. In addition to fever and headache, individuals may experience intense joint and muscle pain, leading to the colloquial term "breakbone fever" to describe the illness. This pain can be so severe that it limits mobility and significantly impacts the patient's quality of life, often persisting even after other symptoms resolve, thus prolonging recovery times. Alongside these symptoms, many patients report gastrointestinal issues, including nausea, vomiting, and loss of appetite, which contribute to fatigue and general malaise, making the infection particularly challenging. A rash, which may develop three to four days after fever onset, is another common symptom; it often starts as small red spots and can spread to larger body areas (Figure 5). However, not all individuals infected with the dengue virus will

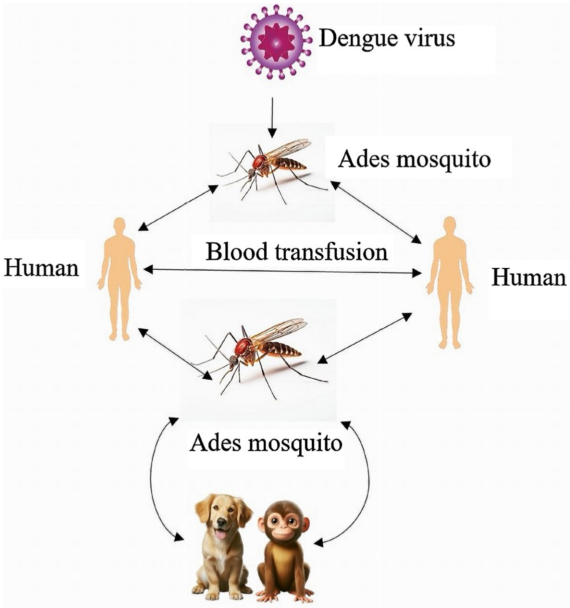

Figure 4. Dengue virus transmission mode between vector and hosts.

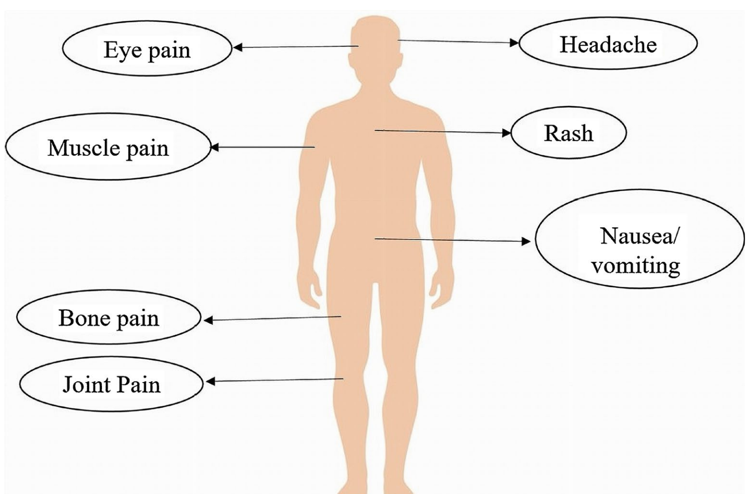

Figure 5. The human body's symptoms affected by *Ades aegypti.*

experience a rash. The appearance of the rash and other symptoms aids healthcare providers in diagnosing dengue fever. While most cases are mild and resolved with supportive care, some individuals may progress to severe dengue, also known as dengue hemorrhagic fever or dengue shock syndrome. Severe dengue is characterized by more serious symptoms that can lead to significant complications, such as severe abdominal pain, persistent vomiting, and bleeding signs, including gum bleeding, nosebleeds, or easy bruising. This bleeding results from the virus's effects on blood vessels, increasing permeability and potential plasma leakage. In severe cases, hypovolemic shock can occur, resulting from significant blood volume loss and dangerously low blood pressure. Organ impairment is another serious complication associated with severe dengue, as the virus can affect vital organs, including the liver, heart, and kidneys, increasing the risk of mortality. Therefore, early recognition and appropriate management of severe dengue are critical; patients exhibiting severe symptoms require immediate medical attention to manage complications effectively and improve outcomes. Overall, the symptoms associated with dengue fever range from mild to severe, making timely intervention essential for those with serious manifestations. Public health education regarding the symptoms and risks of dengue is crucial for early detection and treatment, empowering individuals to seek care promptly and enhancing community efforts to control mosquito populations and prevent outbreaks, ultimately protecting public health.

4. Results

Dengue fever, a mosquito-borne disease affecting millions worldwide, presents a significant public health challenge due to its recurring outbreaks and associated morbidity and mortality. Understanding year-to-year variations in dengue cases and fatalities is essential for informing effective public health strategies, particularly given the disease's unpredictable and often severe outbreaks. Statistical analysis of annual cases and deaths, as detailed in **Table 3**, provides a comparative overview of specific years (2022, 2021, and 2019) against the overall average from 2000 to 2022. Examining these variations alongside the statistical significance (p-values) for each year illuminates trends in dengue incidence and fatalities, whether intensifying or waning. The long-term average from January 2000 to December 2022 reveals a mean of 10,761.8 ± 5064.25 cases and 46.31 ± 15.05 deaths per year,

Table 3. Comparison of deaths and cases by year.

Year	Cases	Death	*p-value*
January 1, 2000, until December 31, 2022	10,761.8 ± 5064.25	46.31 ± 15.05	<0.05*
2022 (January–December 31)	5070.71 ± 2255.34	21.47 ± 11.97	<0.05*
2021 (January–December)	2760.09 ± 891.90	9.76 ± 4.36	0.007**
2019 (January–December)	8556.19 ± 4491.53	16.37 ± 8.10	0.063

with a statistically significant p-value of <0.05, establishing a benchmark for comparing individual years and highlighting deviations from typical annual counts. For instance, in 2022, the reported average of 5070.71 ± 2255.34 cases and 21.47 ± 11.97 deaths also demonstrated statistical significance with a p-value of <0.05, indicating a significant difference from the overall average. Although the case numbers were lower than the long-term average, 2022 still represented a considerable public health burden, evidenced by high mortality rates. This underscores the urgent need for enhanced vector control measures and an improved healthcare response during peak periods to mitigate the impact of dengue fever.

The analysis of dengue fever cases in 2021 reveals a notably lower average of 2760.09 ± 891.90 cases and 9.76 ± 4.36 deaths, accompanied by a highly significant p-value of 0.007, indicating a substantial deviation from the norm. This reduction in cases and fatalities may be attributed to pandemic-related restrictions, which likely limited human movement and decreased mosquito exposure, inadvertently curtailing dengue transmission. This unique scenario underscores the influence of external factors, such as public health interventions targeting other diseases, on dengue incidence. In contrast, 2019 reported an average of 8556.19 ± 4491.53 cases and 16.37 ± 8.10 deaths, with a p-value of 0.063. Although not statistically significant by conventional standards, 2019 experienced a severe outbreak, particularly during the monsoon months. Yet, it had a lower fatality rate than in 2022 and the overall average from 2000 to 2022. These findings highlight 2019 as a critical period for dengue management, emphasizing the necessity for proactive seasonal interventions. Year-wise comparisons of dengue cases and deaths from 2000 to 2022 reveal both statistically significant deviations and the potential impact of external factors on dengue transmission. The relatively high mortality rate in 2022 and the severe outbreak in 2019 underscore the ongoing necessity for consistent vector control and public health preparedness, especially during peak seasons. Conversely, the decline in cases and fatalities in 2021 provides insights into how broader health measures can inadvertently benefit dengue control. This analysis emphasizes the importance of adaptable strategies and a robust public health infrastructure to effectively manage and mitigate the impact of dengue across varying conditions and years.

Figure 6 illustrates the monthly incidence of dengue fever cases and corresponding fatalities over a year, highlighting a significant upward trend, particularly in the latter half of the year. Starting with a modest count of 123 cases in January, the numbers gradually rose until a dramatic surge in July, when cases skyrocketed to 1,620. This upward trajectory continued, peaking alarmingly at 21,955 cases in October. Notably, deaths were absent in the early months; however, as cases surged, fatalities began to emerge, with significant increases recorded in both July and October. This analysis aims to explore the trends in case incidence and mortality, providing insights into the underlying factors contributing to this escalation and the potential implications for public health responses. As the year progressed, the data revealed a concerning pattern, with exponential growth in cases from September onwards. Notably, September recorded the highest number at 9924 cases, followed by October's peak of 21,955 cases and 95 deaths. This surge correlates with an overall increase in mortality, suggesting that the healthcare system may have faced considerable strain during this period. Understanding these dynamics is crucial for devising effective strategies to mitigate similar future trends and enhance preparedness for public health challenges.

Figure 7 outlines the monthly incidence of cases and fatalities throughout the year, providing critical insights into trends associated with this health event, potentially reflecting an outbreak or disease progression. The data from January to December showcases monthly fluctuations in reported cases and deaths. A thorough analysis will illuminate the health situation's dynamics, emphasizing key months of increased activity and their impacts on mortality. The data indicates that July and August experienced a dramatic surge in cases, with July reporting 2278 cases and August escalating to 7640 cases. This period also saw a rise in deaths, with 15 recorded in July and 36 in August, indicating a concerning increase in severity.

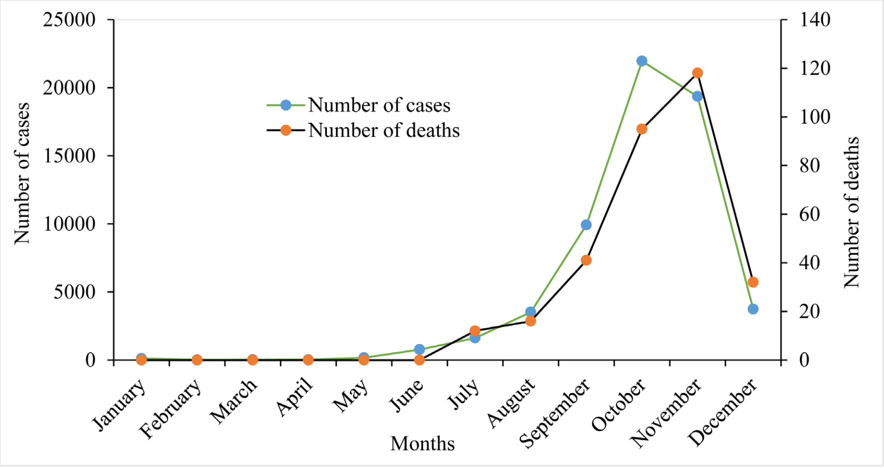

Figure 6. Monthly cases and mortality for 2022 (1 January-30 December).

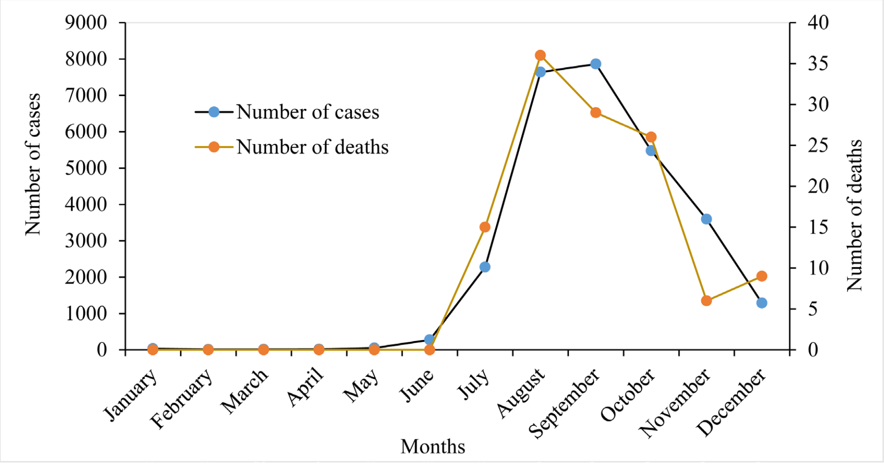

Figure 7. Monthly cases and mortality for 2021 (1 January-30 December).

Subsequent months, such as September and October, also showed high case counts, yet fatalities fluctuated, suggesting potential changes in case management or variations in population vulnerability. This analysis will further explore these trends and their implications for health interventions and community awareness.

Dengue fever, transmitted by Aedes mosquitoes, poses a significant public health challenge in many tropical and subtropical regions, with its seasonal patterns dictated mainly by environmental and climatic factors. The monthly distribution of dengue cases and fatalities provides crucial insights into peak transmission periods, which can assist in effective resource allocation and targeted interventions. Figure 8 illustrates a clear seasonal trend, with dengue cases peaking dramatically during the monsoon months, particularly in July, August, and September—optimal periods for mosquito breeding due to stagnant water bodies. Notably, August records the highest incidence with 52,688 cases and the highest monthly death toll of 92. This peak is followed closely by September, with 16,885 cases and 32 deaths, and July, which reports 16,276 cases and 24 deaths. In contrast, from January to April, the early months of the year see minimal cases and no fatalities, with case numbers ranging from just 4 in January to 38 in March. As the monsoon season progresses, a marked increase in cases begins in June, with 1956 cases and eight deaths. After the peak months, case numbers gradually declined through October, November, and December, with December seeing 3689 cases and only one death. This monthly trend underscores the urgent need for intensified mosquito control and public health measures ahead of the rainy season to mitigate the impact of dengue outbreaks. By understanding these seasonal patterns, health authorities can better anticipate periods of high dengue transmission and prepare effectively to reduce associated morbidity and mortality.

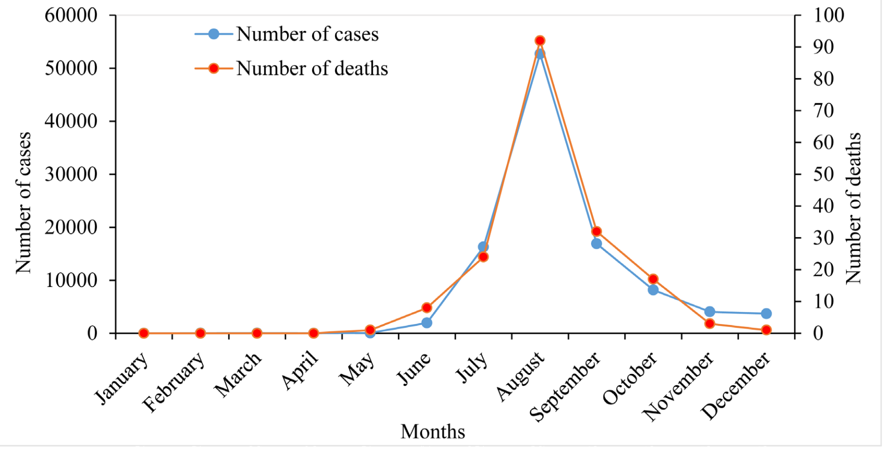

Figure 8. Monthly mortality and cases for 2019 (January 1-December 30).

Figure 9 provides a comprehensive overview of reported dengue cases and fatalities across various regions, highlighting Dhaka and its surroundings as the outbreak's epicenter. Dhaka emerges with the highest number of cases, totaling 36,426, alongside a corresponding death toll of 154, indicating a significant concentration of the disease in the capital. In contrast, the surrounding areas report 3665 cases but only three deaths, suggesting either more effective health interventions or discrepancies in reporting. Other major regions, such as Chittagong, exhibit high infection rates, with 7708 cases and 54 fatalities, making it the second-most affected region in terms of both cases and deaths. Mymensingh and Khulna display moderate infection levels, reporting 991 and 3378 cases, with corresponding fatalities of 4 and 10, respectively. Meanwhile, Rajshahi, Barishal, and Rangpur show fewer cases and relatively low death counts, with Rajshahi recording 1997 cases and five deaths, Barishal 2965 cases and ten deaths, and Rangpur a mere 165 cases with only one death. Lastly, Sylhet reports the lowest figures, with just 112 cases and one death, indicating lower exposure rates or effective containment measures in that area. Overall, the data underscores Dhaka as the outbreak's epicenter, while other regions exhibit varying infection and fatality rates, potentially influenced by regional healthcare capacity, population density, and public health responses.

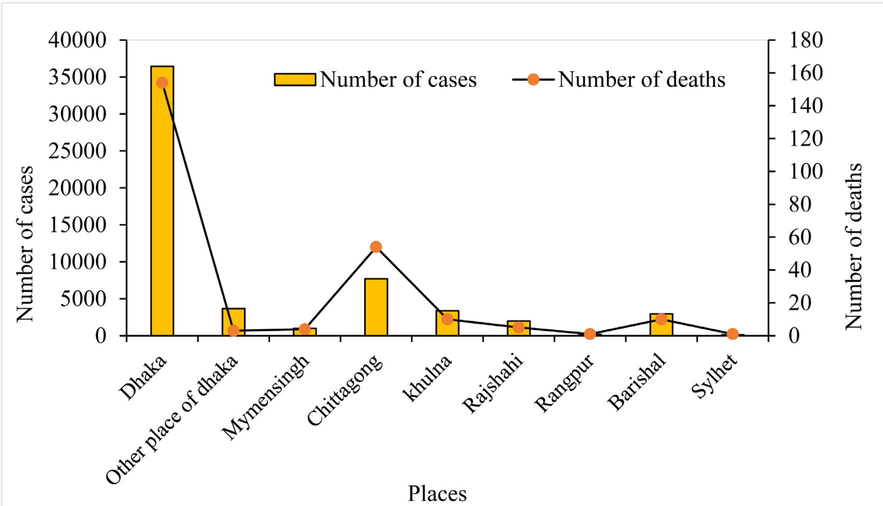

Figure 9. Distribution of dengue cases and deaths by division in 2022.

Figure 10 provides a comprehensive account of daily dengue case counts from October 1 to December 31, emphasizing the significance of temporal analysis in understanding the trajectory of the ongoing health crisis. The data reveal substantial fluctuations in reported cases, with distinct peaks and troughs likely influenced by various factors, including public health interventions, seasonal effects, and disease transmission dynamics. This analysis is crucial for health authorities and policymakers to evaluate the effectiveness of current measures to curb the spread of dengue and to adapt strategies as necessary. Notable trends emerge, particularly in October, where daily case counts begin around 620, exhibiting significant variability before reaching a peak of 1043 cases on October 25. In November, activity remains high, with case numbers frequently exceeding 800, indicating persistent community transmission; the highest daily count is recorded on November 4, with 1049 cases. However, as December progresses, a marked decrease in daily cases is observed, with several days reporting below 300, suggesting a potential transmission decline or improvement in control measures. This analysis underscores the importance of continuously monitoring daily case counts to identify trends and inform public health responses. The observed fluctuations throughout October to December highlight the necessity for ongoing vigilance and adaptability in health interventions, particularly as seasonal and behavioral factors can significantly impact the spread of dengue.

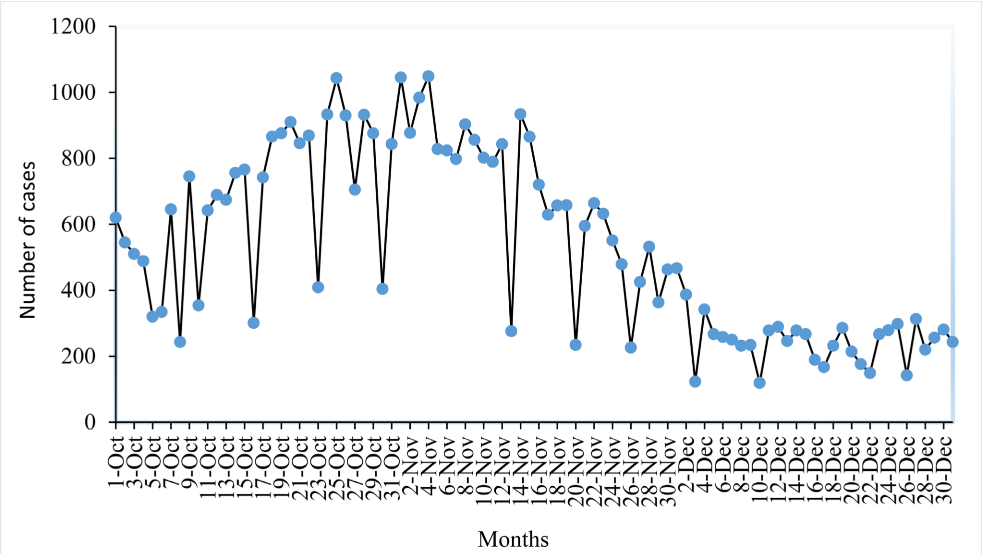

Figure 10. Affected day-by-day (October 1, 2022-December 30, 2022).

5. Discussion

Over half of the world's population lives in dengue-endemic regions in more than 100 nations, and the disease's incidence has tripled in the last 50 years. Positive-sense single-stranded RNA is the genetic material of the encapsulated dengue virus, which belongs to the Flaviviridae family. Life cycle research has found important host targets for the virus's proliferation. Global variables, including rising temperatures and growing human population density, have made dengue fever more likely to spread. Concurrently, the increased range of Aedes mosquitoes has made transmission even more accessible. As a result, dengue has emerged as a significant worldwide health issue, especially in nations with poor and intermediate incomes. When exposed to the dengue virus, children under the age of 15 in Asia are more likely than adults to suffer from serious illnesses. On the other hand, whereas moderate cases are more common in adults in the Americas, there is a concerning pattern of rising Dengue Hemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS) rates in this population.

Dengue is still a significant public health concern in Bangladesh even after considerable attempts to eradicate breeding grounds for mosquitoes have been made to restrict its vectors. In the past, outbreaks were mostly limited to Dhaka until a significant epidemic in 2000 that claimed 93 lives and left 5,551 cases, underscoring the disease's threat to public health. Due to the country's climate, Aedes-borne infections can spread throughout Bangladesh, with mosquito populations increasing during the May-August monsoon season.

During the vector season, the government uses adulticides and larvicides in drainage systems for fogging operations, such as Temephos. According to compiled data, dengue incidence peaks quickly in early July and lasts until December, with over 90% of cases occurring in August and September. Dengue incidence decreased after a notable peak in 2019, possibly due to symptoms that overlapped with COVID-19, making diagnosis more difficult for medical professionals. However, dengue became Bangladesh's top cause of death after the epidemic, with a sharp increase in cases. Dengue fever killed 192 people and infected 46,846 people in 2022 alone. The severity of dengue is highlighted by the fact that 492 of the 788 deaths since 2000 more than 62.44% took place between 2019 and 2022. Dengue prevalence and death are still highest in Dhaka, mainly because of the city's steadily increasing population density.

6. Conclusion

Dengue fever poses a significant threat in Bangladesh, particularly during the monsoon season, where its transmission can escalate rapidly. The situation was further exacerbated in 2022, as the lingering effects of the COVID-19 pandemic intensified the disease's virulence, placing considerable strain on the national economy. To mitigate the risks associated with dengue, increasing public awareness is paramount. The Bangladeshi government is pivotal in this endeavor, implementing educational initiatives, conducting awareness campaigns, and enforcing necessary measures to reduce the disease's impact on public health and the economy. Collaborative efforts between government agencies and communities will be essential to combat this persistent public health challenge effectively.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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