A Seminar Paper on
Challenges and Management of Dengue Outbreak in Bangladesh

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Challenges and Management of Dengue Outbreak in Bangladesh[1]

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ABSTRACT

Dengue is the mosquito-transmitted viral illness that is most prevalent globally. The disease is transmitted through the bite of a female *Aedes* mosquito, mostly the disease-carrying *Aedes aegypti* mosquito and, to a lesser extent, the *Aedes albopictus* mosquito. This review study was prepared to explore the prevalence of dengue outbreaks in Bangladesh as well as to assess the difficulties and management of such outbreaks. Since 2000, dengue outbreaks have occurred practically yearly in Bangladesh, and the most severe dengue outbreak to date occurred in Bangladesh in 2019. With 60,078 cases and 266 fatalities due to the disease documented as of the last of December, the 2022 dengue outbreak was the second-largest since 2000. All four dengue virus serotypes are common and contagious in Bangladesh. A promising tactic for limiting dengue outbreaks is to reduce mosquito vector activity at the ideal time each year. Also, we discussed a number of dengue vector control strategies, environmental preventive measures, and World Health Organization (WHO) recommendations for the best and most effective course of action to deal with possible dengue epidemics in Bangladesh.

Keywords: *Aedes aegypti, Aedes albopictus*, Challenges, Dengue virus, Serotypes, Vector control.

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CHAPTER I

INTRODUCTION

The most widespread viral disease worldwide transmitted by mosquitoes is dengue. A member of the Flaviviridae family, the dengue virus has a single strand of positive polarity RNA. It is spread through the bite of a female mosquito of the genus *Aedes*, mostly the species *Aedes aegypti* and, to a lesser extent, *Aedes albopictus*, that is afflicted with the disease. Zika, chikungunya, and yellow fever viruses are also spread by this mosquito (Rahman et al., 2019). Both species are responsible for the diseases dengue shock syndrome (DSS), dengue hemorrhagic fever (DHF), and classical dengue fever (DF). In contrast to DHF and DSS, which collectively are referred to as "severe dengue," which can be fatal, classical DF is often a minor sickness similar to the flu. In 10 nations of the World Health Organization (WHO) South-East Asia Region, which includes Bangladesh, approximately 52.0% of the global population is at risk of contracting dengue (WHO, 2011). The virus has 4 different serotypes that are connected to one another (DEN-1, DEN-2, DEN-3 and DEN-4). A serotype or serovar is a distinctive variant found in immune cells from various people or within a species of bacteria, virus, or another organism. Also named as DENV (Dengue Virus). The risk of developing severe dengue increases with subsequent infections (secondary infection) caused by different serotypes (Rahman et al., 2019). More than 100 nations throughout the world have dengue, which is widespread in Asia, the Pacific, Africa, and Latin American nations. Three billion people, or 40% of the world's population, reside in dengue-risk zones. 22,000 people die from severe dengue each year. Trends in human ecology, demography, and globalization are linked to the rising incidence, intensity, and frequency of dengue outbreaks; climate change may also have had an impact.

In this case outbreak of dengue means a higher than usual incidence of a dengue at a specific time and location. The first case of dengue infection in Bangladesh was discovered during a 'Dacca Fever' outbreak in the capital city (now Dhaka) in the late summer of 1964. Type 3 of the dengue virus was found (Russell et al., 1966) then. Sporadic instances and minor outbreaks with clinical dengue symptoms happened all around the country between 1964 and 1999, but they weren't formally documented. An outbreak began in the summer of 1999 in and around Dhaka, and the first DF epidemic was formally recognized in 2000 (Yunus et al., 2001; Wang et al., 2002). The greatest pandemic on record was found in 2002 after 2000. Although exact case numbers are not

fully known, hospital-based surveillance notifications have decreased since 2002 (Bhatt et al., 2013 & ICDDRB, 2014). Following then, Bangladesh had no DENV-3 or DENV-4 reports. Between 2013 and 2016, DEN-2 predominated in circulation, followed by DEN-1. The Institute of Epidemiology, Disease Control Research (IEDCR) predicted that secondary dengue outbreaks could soon occur in Bangladesh's neighbors due to the presence of serotypes DENV-3 and DENV-4 there (Muraduzzaman et al., 2018). After DENV-3's reemergence was discovered in 2017, there was a dramatic increase in dengue infections starting with the start of the monsoon season in 2018 (Shirin et al., 2019). Dengue outbreaks in 2019 broke all previous records, with the capital city of Dhaka seeing the majority of cases. It is extremely difficult to control dengue fever outbreaks in tropical nations where year-round temperatures are ideal for mosquito reproduction and viral replication. In addition, managing large dengue epidemics requires enormous financial resources, the use of pesticides to reduce the mosquito population, and the management of ill hospital patients. The City Corporation/Municipality is mandated by the local government to reduce mosquito populations in Bangladesh at the moment. In particular, during the peak dengue season (August to September), when hospitals frequently find a significant number of dengue cases, the program is primarily focused on spraying insecticidal chemicals that are meant to kill adult mosquitoes (Al-Amin et al., 2020). In order to attain the lowest biting population when environmental conditions for emergence and transmission are most favorable, one of these points of intervention entails limiting the mosquito vector activity at the ideal moment in annual population fluctuations. The history of the dengue epidemic in Bangladesh is discussed here. With a focus on the population, human behavior and climate, causes for the disease's emergence and establishment are taken into account. In addition, I've outlined crucial challenges to management program implementation in Bangladesh regarding incidence and distribution of dengue.

Therefore, the goals of this seminar paper are:

- To explore the prevalence of dengue in Bangladesh.
- To assess the difficulties caused by the dengue outbreak in Bangladesh.
- To evaluate the dengue epidemics handlings and control techniques.

CHAPTER II

MATERIALS AND METHODS

This work for the seminar is solely a review article. The paper only used secondary sources for its data and information. Hence, no particular research techniques were used to create this work. I gathered the data and information from a variety of published papers, journals, online articles, reports and the internet. The majority of the required resources came through internet searches. The paper is then created after the data have been compiled.

Last but not least, my major professor and the distinguished seminar course teachers helped me prepare this seminar paper.

CHAPTER III

REVIEW OF FINDINGS

3.1. Dengue Virus Epidemiology and Serotypes' Relationship to Disease Severity

Dengue is a viral infection transmitted to humans through the bite of infected mosquitoes and is found in tropical and sub-tropical climates worldwide, mostly in urban and semi-urban areas. *Aedes aegypti* mosquitoes and, to a lesser extent, *Aedes albopictus* mosquitoes are the main carriers of the disease. Each of the four serotypes of the dengue virus (DENV) like DENV-1, DENV-2, DENV-3, and DENV-4 can cause infection. Sequential infections put persons at higher risk for severe dengue; infection with one serotype confers long-term immunity to the homologous serotype but not to the other serotypes. DENV can cause an acute flu-like illness.

Aedes aegypti

Aedes albopictus

Figure 1: *Aedes* species responsible for dengue virus infection (www.google.com)

In Bangladesh, dengue seems to be a substantial factor in morbidity and mortality. Bangladesh is at risk for dengue at a frequent/continuous level, using the Centers for Disease Control and Prevention's (USA) risk scale (CDC, 2022). Different epidemiological trends can be seen in dengue outbreaks linked to the four different serotypes. DENV-3 was shown to be the predominant serotype in Bangladesh's initial dengue epidemic in 2002 (Islam et al., 2006). DENV-1 and DENV-2 were, nevertheless, Bangladesh's most common serotypes from 2013 to 2016 (Huhn, 2021). DENV-2 was the most common serotype in Dhaka City in 2017 (91.3%) (Rahim et al., 2021). The cocirculation of serotypes 2 (54%) and 3 (46%) was discovered by phylogenetically analyzing samples taken during the 2018 outbreak in Bangladesh (Ahmad et al., 2020). DENV-2 was shown to be the most common serotype in 2018 among 127 cases, followed by DENV-3 (33.07%) and

DENV-1 (25.98%) (Rahim et al., 2021). DENV-3 was the predominant serotype throughout the 2019 and 2021 epidemics (Rahim et al., 2021 & Hsan et al., 2019).

When more than one DENV serotype is prevalent in the country's endemic regions, severe dengue cases are frequently seen (Loroño-Pino et al., 1999). Given that Bangladesh has received reports of four different DENV serotype infections (DENV-1, DENV-2, DENV-3, and DENV-4), which suggests co-circulation of all four DENV serotypes (Ahmad et al., 2020 & Shirin et al., 2019), the risk of reinfection with heterologous DENV may be increased (Katzelnick et al., 2017), posing a serious risk for severe dengue outbreaks in Bangladesh in the near future.

Table 1: Serotype status for dengue in various years

Year	Dengue serotypes Status
2013 to 2016	DEN 2 (predominant) followed by DEN1
2017	DEN 2 (predominant) followed by DEN1 and co detection of DEN 3 with DEN 2 (few cases)
2018	DEN 2 (predominant) followed by DEN2 and DEN1 and co-detection DEN2 & DEN3 and DEN1 & DEN3(few cases)
2019	DEN 3 (predominant) followed by co-detection of DEN2 & DEN3 and DEN1 & DEN3 (few cases)

(Akram, 2019)

However, Bangladesh's enhanced genetic diversity of DENV (Ahmad et al., 2020) foresees the disastrous effects of a widespread dengue outbreak. Additionally, people who recover from a dengue infection with one serotype can build strong immunity against that specific serotype, but they cannot prevent infection by other serotypes. The emergence of severe dengue as well as an increase in mortality may result from these heterotypic infections (Kayesh et al., 2023).

3.2 Dengue History in Bangladesh

In Dhaka, Chittagong, and Khulna in 2000, the first Severe dengue fever (SDF) epidemic took place. A total of 5551 dengue illnesses were documented during this pandemic, and 93 individuals passed away (Yunus et al., 2001). According to Sharmin et al. (2015), a virus strain that originated in Thailand, a country to the east of the country, was the origin of the outbreak that occurred in 2000. Although mortality rates have significantly decreased since the 2000 outbreak, a sizeable population still contracts DENV every year. Then unexpectedly, both the number of dengue cases

and fatality rates in 2018 increased. The highest incidence and mortality were noted in 2019. Last but not least, after 2019, the second-highest outbreaks were discovered in 2022 (Table 2).

Table 2: Year wise dengue cases and deaths in Bangladesh till now

Year	Number of affected people	Death
2000	5551	93
2001	2430	44
2002	6282	58
2003	486	10
2004	3934	11
2005	1048	4
2006	2200	11
2007	466	0
2008	1153	0
2009	474	0
2010	409	0
2011	1359	6
2012	671	1
2013	1749	2
2014	375	0
2015	3162	6
2016	6060	14
2017	2769	8
2018	10148	26
2019	101354	164
2020	1405	3
2021	28429	105
2022	60078	266

(Akram, 2019)

3.2.1 Dengue Outbreaks in Dhaka

The distribution of dengue cases and fatalities in Dhaka between the years of 2001 and 2019 is depicted here (Figure 2). Although dengue occurrences have declined since 2001 till 2015, they have continued to follow cyclical and changing patterns. It is clear that the number of fatalities has

drastically decreased-from 44 in 2001 and 58 in 2002 to none in 2014 (Figure 2). It subsequently began to rise, resulting in an expected 41 deaths in 2018 and 87 deaths in 2019. In 2019 there were significantly more deaths and cases of dengue reported. Between 1 January and 13 September 2019, there were a total of 80,040 dengue cases that were formally documented, and there was a total of 60 deaths from SDF and shock syndrome (Shirin et al., 2019). All four DENV serotypes are present in Dhaka, with DENV-3 predominating, according to the research that is currently available (Dhar-Chowdhury et al., 2017). DEN-3 predominated during the significant outbreak in 2002, and as a result, other serotypes were later discovered to be in circulation.

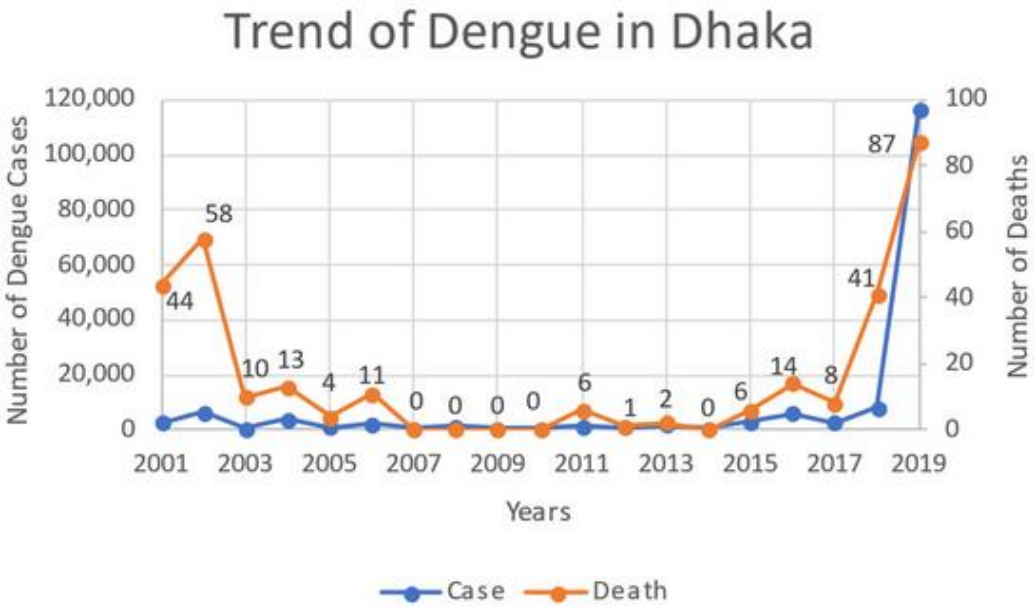

Figure 2: Distribution of dengue cases and fatalities in Dhaka, Bangladesh, between 2001 and 2019. (Shirin et al., 2019)

3.3 Recent Outbreak Status of Dengue in Bangladesh

A record-breaking 281 deaths from dengue were reported by the Bangladesh Directorate General of Health Services (DGHS) at the end of 2022, easily beating the previous high of 179 deaths from the disease in 2019. 108 deaths occurred outside of Dhaka, according to the DGHS data, whereas 173 deaths (or 61%) occurred there. 69 deaths were reported in Chattgoram division after Dhaka (63%) (Figure 3). With far over 100,000 cases, 2019 was an all-time high for dengue hospitalizations in Bangladesh. Although dengue is widespread in Bangladesh, a spike in occurrences began in June 2022. All eight of the country's divisions are at this time reporting cases

and fatalities. The biggest epidemic since 2000 happened in 2019, as seen in the figure below, making this one the second-largest.

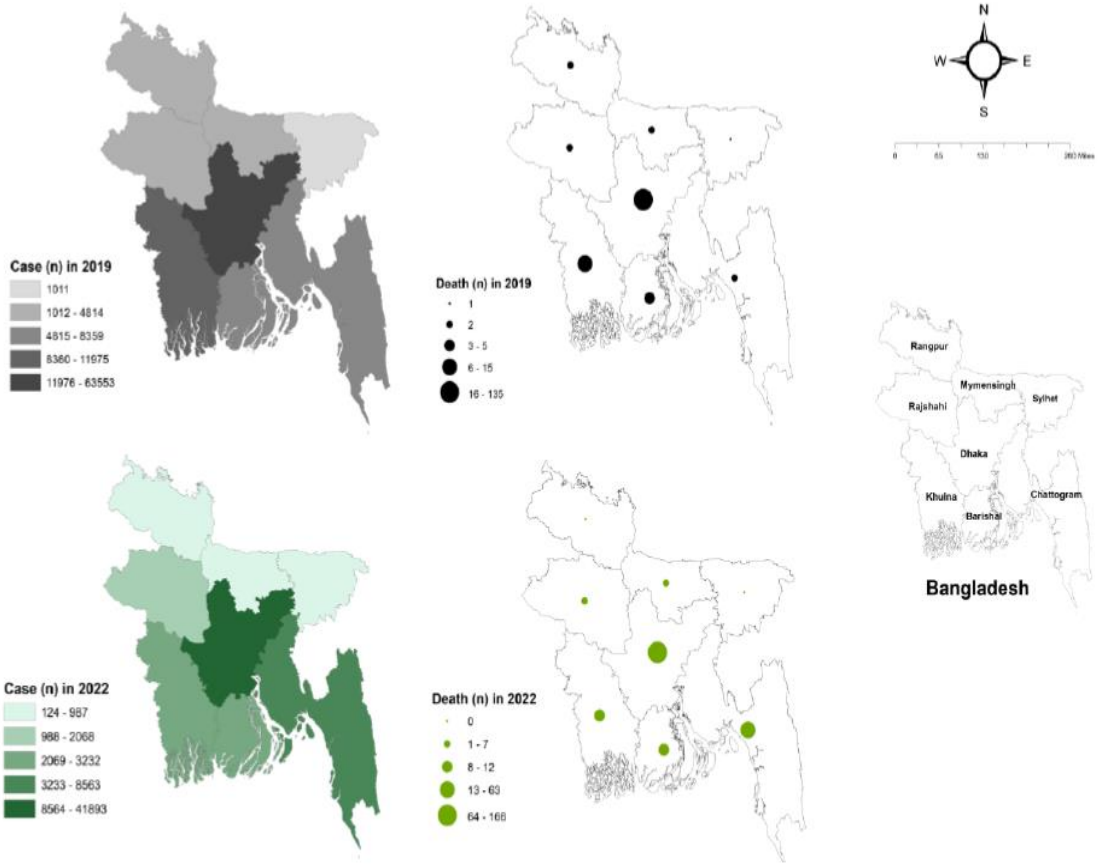

Figure 3: The number of dengue case and dengue-related death in the years 2019 and 2022 (as on 10 December 2022) in different divisions (Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Barishal, Rangpur, and Mymensingh) of Bangladesh are shown. (Kayesh et al., 2023).

Figure 4 displays the number of dengue cases and fatalities from January 1 to December 31, 2022. It is showing that there were no death records for the first four months. Monthly death records started to rise after June-July. And the months of October and November have the highest numbers of dengue infections and fatalities. After November, a decline in numbers was seen. 260 deaths total, with more than 100 occurring in November, were reported from September through December.

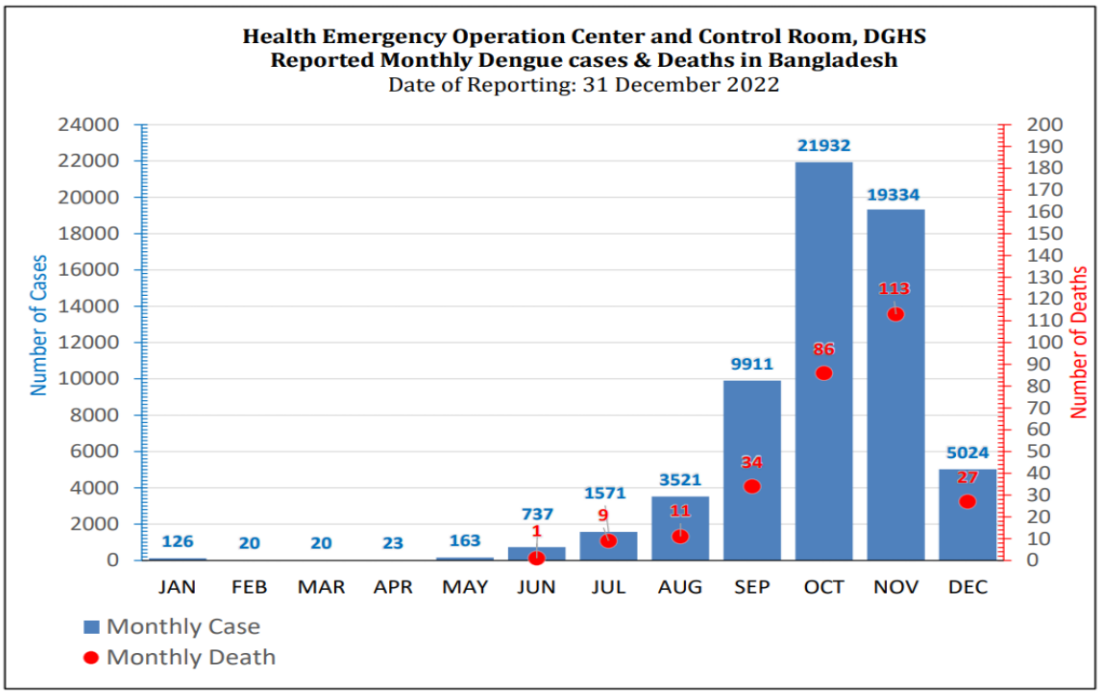

Figure 4: Number of dengue cases and deaths reported in Bangladesh from 1 January to 31 December 2022. (News Desk, 2023)

The graphical representation of dengue cases and death rates from 2000 to 2022 is shown in the Figure 5. We can see that dengue cases and mortality rates increased between 2000 and 2001. Later, in 2003, there were a lot of fatalities. Following that, the numbers continued in a somewhat continuous trend until 2018. The nation has had the greatest number of dengue cases in 2019. Later on, a rise in dengue cases in 2022 was discovered.

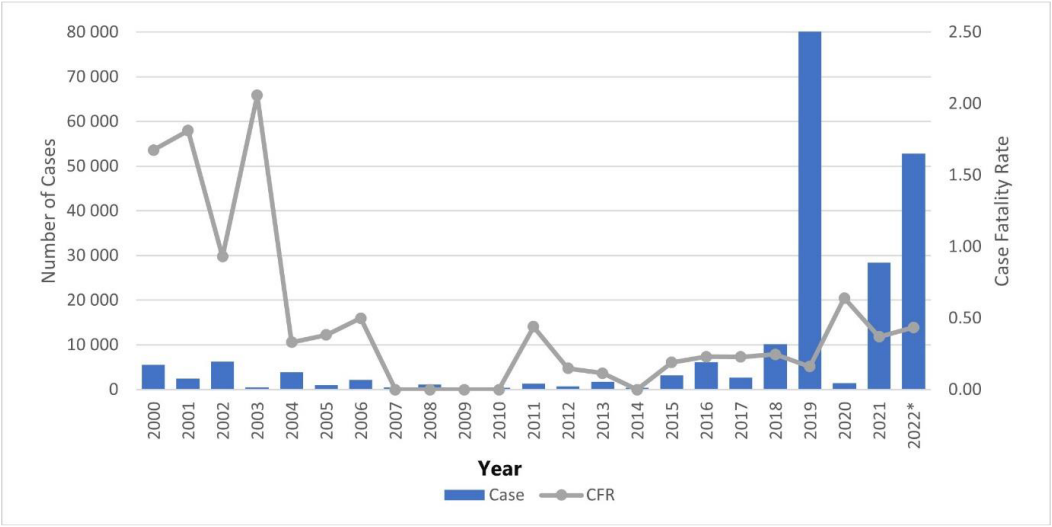

Figure 5: Number of dengue cases and case fatality rates reported by year in Bangladesh from 1 January 2000 to 20 November 2022 (WHO, 2022).

3.4 Challenges Resulting from the Dengue Outbreak in Bangladesh

Now a days dengue has reached pandemic proportions and become a major public health concern. It has emerged and re-emerged across the globe to cause larger, more frequent and severe outbreaks involving areas thus far unaffected. As per the World Health Organization (WHO) fact sheet, dengue is endemic in >100 countries with 50 per cent of the world population at risk. The WHO (2013) estimates that around 500,000 people every year are hospitalized for severe dengue infection.

3.4.1 Population Breakdown and Urbanization

One of the nations with the densest populations is Bangladesh. Population density grew from 484 to 843 people per square kilometer between 1974 and 2001 (BBS, 2001). There are currently more over three million births every year, and there are 964 people per square kilometer. Bangladesh's 154.7 million residents lived in urban areas in 2012, making up 29.0% of the population; by 2050, this percentage is projected to rise to 52.2% (BBS, 2011). The four major cities in the country-Dhaka, Chittagong, Khulna, and Rajshahi-are home to more than half of the urban population, making Dhaka the most populous city in Bangladesh (UNICEF, 2015). The usage of unprotected water reservoirs, poor city management, and a lack of adequate waste disposal, sanitation, drainage, and water supply all contribute to the creation of environments that are appropriate for *A. aegypti* and *A. albopictus* (Heilig G, 2012). Transmission is facilitated by a large number of mosquito breeding sites, together with unrestricted mosquito-human contact brought on by the absence of window and door screens (Table 3). These neighborhoods are inhabited to the urban poor, who make up around 35.2% of the total population of the six major cities of Dhaka, Chittagong, Khulna, Rajshahi, Barisal, and Sylhet (Angeles et al., 2009). People store water in temporary containers like drums and earthen jars, in which *A. aegypti* lays eggs, in the overcrowded communities known as colonies, which lack access to piped water (Hossain et al., 2000).

Table 3: The location with the highest productivity for vector breeding sites

Location	Type of a wet container	Number of larva & pupae collected	*Aedes aegypti* (%)	*Aedes albopictus* (%)
Indoor	Plastic drum	352	15.27	0
	Plastic bucket	307	14.75	0
	Flower tab and tray	99	2.4	0
	Tires	196	5.76	2.69
	Water tank	28	0.77	0
Outdoor	Plastic bucket	307	12.65	0.13
	Plastic drum	171	11.08	0
	Clay pot	146	7.24	0
	Tires	135	7.17	0
	Water tank	136	6	0

(Mutsuddy et al., 2019)

3.4.2 Climate and Environment

Bangladesh experiences a hot, muggy, monsoon environment. About 45% of the average annual rainfall, which ranges from 1527 mm in the west to 4197 mm in the east, occurs between June and September during the monsoon season (Shahid & Khairulmaini, 2009). Rainfall overflows outdoor artificial containers, which act as breeding grounds and cause an increase in dengue prevalence (Heng et al., 1998). Extremes in rainfall have an impact on mosquito survival as well; female *A. aegypti* mosquitoes typically have a lower chance of surviving in very low and very high rainfall conditions (Fouque et al., 2006). But while heavy rain might boost human-mosquito contact in the humid days that follow by dissuading people from covering themselves, low rainfall can also promote mosquito breeding by encouraging the storage of water in artificial containers. During the monsoon, the country's mean temperature averages out to about 29.0^{o}C, with a mean diurnal temperature range of 6.1^{o}C (Shahid et al., 2012). This is ideal for the growth of mosquitoes and the spread of DENV (Lambrechts et al., 2011). The western region of Bangladesh is comparatively dry, whereas its southern region is comparatively warm. Every three to five years, severe floods inundate nearly 60% of the nation; three big floods occurred between 1987 and 2000, with the 1998 storm being the longest and most geographically extensive and displacing 21 million people, severely damaged infrastructure, including the water supply, and changed how water is stored as

a result (Alam & Rabbani, 2007). High rainfall was again experienced the following year as a result of the moderate flood. A severe flash flood that never before occurred in the country's southwest in 2000 undoubtedly aided in the spread of dengue. By 2050, it is predicted that annual mean temperatures would rise by 1.4ºC and annual mean precipitation will rise by 5.6% from the baseline normal (Agrawala et al., 2003). Due to subsequent increases in the frequency of severe droughts during the pre-monsoon because of higher winter temperatures (December to February) and high monsoon rainfall, *A. aegypti* and *A. albopictus* populations may become more abundant. In Dhaka, hospitalizations for dengue fever surged between 2005 and 2009 as river levels rose after a protracted period of low levels (Hashizume et al., 2012). Longer-lasting and more frequent pre-monsoon droughts in the future could cause monsoon floods, which would accelerate the spread of dengue. Figure 6 depicts the connection between dengue problems and the many meteorological elements that cause its incidence.

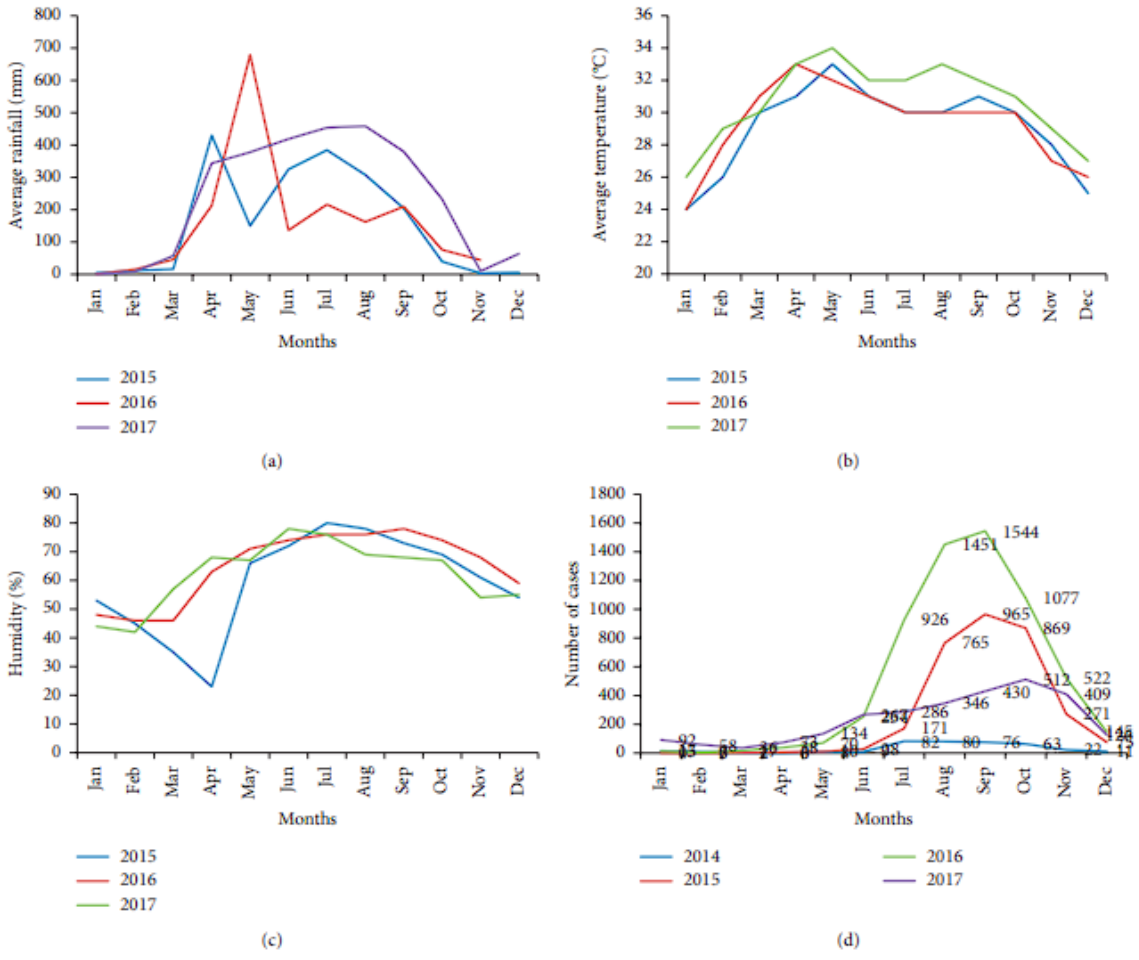

Figure 6: Average climate data (rainfall, temperature, and humidity) after 2014 show correlation analysis with the dengue cases from 2014 to 2017. The analysis showed a significant relationship

between dengue incidence and climate factors: (a) comparison of rainfall by year, 2015-2017; (b) comparison of temperature by year, 2015-2017; (c) comparison of humidity by year, 2015-2017; (d) comparison of dengue cases by year, 2014-2017. (Mutsuddy et al., 2019)

3.4.3 Movement of the Population

Because of violence, natural disasters, economic need, and environmental degradation, people move within Bangladesh. Movement across borders is common for economic, touristic, cultural, and political reasons. The spread of dengue may be facilitated by the travel of viraemic (Pertaining to viraemia; having a virus or viruses present in the bloodstream) people as well as the unintentional transportation of infected mosquitoes. The virus that started the 2000 outbreak was likely imported from Thailand, and more introductions are anticipated to take place in the future (Sharmin et al., 2015).

3.4.4 Surveillance

According to national recommendations based on WHO criteria, suspected dengue is clinically diagnosed, with probable and confirmed cases necessitating positive serological testing and virus isolation, respectively. Since 2000, it has been legally required to notify the Directorate General of Health Services of all suspected, probable, and confirmed cases; nevertheless, as of 2010, only serologically confirmed cases have been reported (Directorate General of Health Services, 2000). According to DGHS, Dhaka, the existing passive surveillance system only reports patients admitted to hospitals, underestimating the number of symptomatic dengue cases (WHO, 2010). It is possible that treatment seeking behavior, which varies geographically depending on the caliber and accessibility of medical facilities and is influenced by gender and socioeconomic position, may skew estimates of occurrence.

3.4.5 Lack of Diagnostic Facilities

Inconsistent diagnoses are caused by a lack of diagnostic resources at the district and sub-district levels. Using unauthorized medical services is widespread in rural Bangladesh. At first, surveillance was only conducted throughout the epidemic period, which started soon after the monsoon arrived and continued until December (Ahsan et al., 2012). But since then, surveillance has been ongoing. The national surveillance system has to be improved to produce accurate incidence data. Accessibility to currently inaccessible information on vector distribution and population is also required (Sharmin et al., 2015).

3.5 Management of Dengue Outbreak

In Bangladesh, prevention and control measures must be improved immediately. All healthcare facilities must have the equipment necessary for the early diagnosis of dengue infection, including a diagnostic laboratory. Finally, in order to lower fatality rates, professionals in Bangladesh must receive training in treating severe dengue (Hsan et al., 2019a). Eliminating mosquito breeding grounds is the primary way of vector management, but cooperation and community awareness are crucial for the implementation of preventative and control measures. In addition to these precautions, behavioral changes made at the home level, such as wearing protective clothes, using repellents, and removing sources of standing water etc. In order to comprehend the biology, bionomics, and breeding behaviors of infectious female *Aedes* mosquitoes, investments in vector surveillance must be intensified. The key to controlling dengue is to take a preventative strategy rather than a reactive one.

3.5.1 Vector Control

Initiating control measures, such as source reduction, larvicide treatment before to the start of the mosquito season, and adulticide use to kill adult mosquitoes are all essential components of effective vector-based DENV prevention. Mass trapping can also be employed to control *A. aegypti* numbers, which should aid in the eradication of dengue, according to recent studies (Barrera, 2022). The benefits of sleeping with a bed net for avoiding contact with dengue vectors are widely acknowledged (Saied et al., 2015). National guidelines for the control of various mosquito-borne illnesses, such as dengue, are available in Bangladesh; their good implementation should reduce the frequency of dengue outbreaks (DGHS, 2000). Physical, chemical (Table 3) and biological control (Table 4) are the main vector control methods used to combat *A. aegypti* and *A. albopictus*.

Table 4: Physical and chemical vector control methods that target *Aedes aegypti* and *Aedes albopictus*

Vector Control Techniques	Application to Mosquito Breeding Areas or Habitats	Strengths	Limitations
Physical control: Habitat management	Can be applied on a wide range of artificial containers	Proper habitat management may prevent or reduce the breeding of *Aedes* mosquitoes in the used tires, discarded containers, flowerpots, etc.	Requires continuous surveillance for habitat removal
Chemical control: insecticides, larvicides	Can be used against adult mosquitoes and larvae including as space treatment, indoor residual spraying and insecticide-treated bed nets. Can be used in small water-storage containers.	Mainstay of vector control worldwide, playing a major role in the prevention and control of vector-borne diseases, including dengue.	Insecticide resistance may compromise vector control efficacy, requiring resistance monitoring systems; might not be ecologically friendly

(Kayesh et al., 2023)

Although it needs more research, Bangladesh's biological approach to DENV infection appears to hold promise for eradicating dengue there. Copepods like *Macrocyclops albidus* and *Mesocyclops* spp. have been used in a number of studies to biologically control dengue vectors (Table 4), although research into this topic is still pending in Bangladesh. Interestingly, a comparison of the relative efficacy of vector-control measures found that adulticide treatment is the most efficient strategy, followed by limiting exposure to mosquito bites, detecting and eliminating breeding grounds, and finally, the use of larvicides (Kayesh et al.,2023).

Table 5: Different biological control methods with their advantages and disadvantages

Vector Control Techniques	Application to Mosquito Breeding Areas or Habitats	Advantages	Disadvantages
Biological control: Wolbachia-mediated biological method	Release of wolbachia-infected mosquitoes to the local mosquito populations.	New, affordable, and more environmentally friendly than applying pesticides is wolbachia-mediated dengue vector control. Cytoplasmic incompatibility can be completely induced by it.	Transmission may not occur because some of the mosquitoes may not live for a period longer than extrinsic incubation period of arboviruses. Further studies are warranted for confirmation of dengue vector control for the effectiveness of the method.
Sterile insect technique (SIT)	Applied to mass-reared male mosquitoes to make the males sterile.	Could be used as a powerful complement to most commonly used approaches because of its ecologically benign, specific, and non-persistent nature in the environment.	Manual separation of males and females is required; successful reduction in populations only achieved in a few instances.
Use of larvivorous fish *Poecilia reticulata* (guppy) and *Gambusia affinis* (Mosquito fish)	Can be used in water storage containers.	It helps in the reduction of immature larvae	The chance of off-target effects such as targeting of other arthropod species cannot be ignored.
Use of copepods (mainly *Mesocyclop*s and *Macrocyclops* species)	Can be applied to control of container-inhabiting mosquitoes	High predation efficiency	Most effective against first instar larvae.
Use of biological larvicides: *Bacillus thuringiensis* Subspecies *israelensis* (Bti)	Can be applied to water-storage containers	Little or no impact on non-target organisms and no accumulation in the environment	Difficulty in maintenance, storage, and transportation

(Kayesh et al., 2023)

3.5.2 Environmental Prevention

Environmental improvements are required for the prevention of dengue cases. The environment won't be as conducive for the vector to breed if people in our nation are aware of the predicament.

Table 6. Environmental preventive measures

Categories	Strategies
Environmental change	• by long-lasting physical changes • supplying cities with a steady water supply through pipes, including residential connections can help limit the habitats used by vector larvae.
Manipulation of the environment	• regular emptying and cleaning by scrubbing of water-storage containers, flower vases, and desert room coolers; • cleaning of gutters; • sheltering stored tires from rain; • recycling or proper disposal of discarded containers and tires; • management or removal of plants like ornamental or wild bromeliads
Alterations in human habitat or behavior	• utilizing mosquito nets while sleeping during the day • placing mosquito screening on windows, doors, and other access points to prevent human-vector contact.

(WHO, 2022)

3.5.3 Management Strategies Advised by WHO

Effective vector control is crucial for dengue prevention and management. In order to eliminate mosquito vectors, particularly the mosquito genus *Aedes,* WHO promotes a tactical strategy known as Integrated Vector Management (IVM) (the primary vector for dengue). IVM needs to be improved to get rid of possible breeding grounds, cut down on vector populations, and limit individual exposure. Strategies for protecting people and homes should also be included, in addition to vector control techniques for larvae and adults (e.g., environmental management and source reduction, biological control, and chemical control measures). In Bangladesh, the IVM plan developed in 2021 should be put into action.

All areas where there is a risk of human-vector contact should be the focus of vector control efforts (place of residence, workplaces, schools and hospitals). There are a few vector control strategies that can be implemented, including weekly covering, draining, and cleaning of home water storage

containers. As a last resort, insecticide can be sprayed into the air. For water storage in outdoor containers, chlorination and the use of proper larvicides/insecticides should also be taken into consideration. Using repellents topically on exposed skin or on clothing, wearing long sleeve shirts and slacks, and other personal protective measures are recommended when engaging in outdoor activities. Utilizing household aerosol insecticides or mosquito coils can help provide indoor protection. The likelihood of mosquitoes entering the house can be decreased by window and door screens, air conditioning, and other measures. People who sleep during the daytime can avoid mosquito bites by using insecticide-treated nets. Due to the fact that *Aedes* mosquitoes are most active at dawn and dusk, personal protection measures are advised, especially during these hours of the day.

Although there is no specific therapy for dengue infection, early case discovery, recognition of any severe dengue warning signs, and prompt access to appropriate clinical management are crucial components of care to lower the risk of severe dengue illnesses and dengue-related mortality. Case surveillance needs to be improved nationwide and in all impacted regions. Resources should be set aside wherever possible to improve laboratory sample referral systems for the identification and sub-typing of the dengue virus.

CHAPTER IV

CONCLUSION

The outbreak of Dengue has become prevalent in Bangladesh in the recent past and the country is facing a number of challenges to manage the severity of this disease. According to the current findings, it can be concluded that-

1. Dengue fever has been a problem in Bangladesh since 2000. Dengue cases and fatality rates increased in 2019 and 2022.
2. It is difficult to control dengue outbreaks in tropical nations like Bangladesh, where year-round warm temperatures are ideal for mosquito reproduction and viral replication.
3. The national health guidelines have implemented preventative and controlling measures. In order to reduce the burden of dengue in Bangladesh, eliminating the vector before it becomes an adult could be a great approach. It is important to inform people of the issue, which can be done in a variety of ways.

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