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CLINICAL MANIFESTATIONS AND SEASONAL OCCURRENCE OF PATIENTS WITH DENGUE HOSPITALIZED AT DHAKA CITY OF BANGLADESH IN 2021

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Key words: Dengue, clinical manifestations, seasonal variation

Abstract

For the past few years, the intensity of dengue in Bangladesh has been rising. The current study was done among 533 dengue patients hospitalized in 2021 in Dhaka to observe the different aspects of clinical manifestations and seasonal occurrence of dengue. Due to COVID-19 restriction, hospital entry and face-to-face interview of the patients was not possible. Hence, contact numbers of the hospitalized dengue patients were collected from Directorate General of Health Services (DGHS) and patients were interviewed over the phone. Out of 533 patients, majority were from Dhaka south city corporation (DSCC) (53.7%), had a monthly household income of 30001≥ BDT (67.4%), and lived in small sized families (76.9%). High fever ($p=0.013$), headache ($p<0.001$), body pain ($p<0.001$), vomiting/nausea ($p=0.0085$), skin rash ($p=0.033$), eye lesion/red eyes ($p=0.0011$), pleural effusion ($p=0.0404$), weakness ($p=0.017$) and gum bleeding ($p=0.014$)- were significantly associated with age groups whereas vomiting/nausea ($p=0.048$), skin rash ($p=0.002$) and eye lesion/red eyes ($p=0.032$) were significantly associated with gender. 86.7% suffered from thrombocytopenia (<150000 per microliter blood), while 27% were in serious condition with lowest platelet count ≤ 20000 per microliter blood. 3.6% patients were admitted to ICU and 1.7% died of dengue. Death due to dengue was significantly associated with age groups ($p <0.05$) and majority among them were children (≤ 10 years). Family members of 44.6% patients were also affected with dengue and majority of the patients belonged to small sized families. Dengue occurrence had significant association with season where majority of the patients were from monsoon season (65.29%) followed by post-monsoon (33.21%) season. Dengue manifests a wide spectrum of symptoms as shown by the study, so now it is necessary to identify the changes in pattern of the clinical manifestations, and effective disease management to lessen the severity of the outbreak.

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Introduction

Dengue is currently one of the major concerns in public health sector of Bangladesh. Dengue virus (DENV), the causal agent responsible for dengue infections, has four antigenically different serotypes, and a new serotype (DENV-5) was reported in Malaysia in 2013[1]. Female *Aedes* mosquitoes are the vectors that transmit the virus to humans, particularly the species *Aedes aegypti* and *Aedes albopictus*. The disease burden of dengue is sharply rising worldwide in recent years with annual 390 million cases[2]. Bangladesh, because of its location in South-East Asia, has become a favorable home for dengue vectors[3]. For the past few years, an alarmingly high number of dengue cases have been reported throughout the country, with Dhaka being the city with the highest dengue prevalence[4]. In 2018, a total of 10,148 cases and 26 deaths[5] were reported whereas in 2019, the dengue scenario surpassed all the previous records with 101,354 cases of infection and 164 confirmed cases of death[6]. Although the infection rate dropped in 2020, it rose again in 2021, with 28,429 cases and 105 fatalities[6]. These data solely include information from hospitals, excluding a significant number of people who had minimal symptoms and did not seek medical attention. Furthermore, after COVID-19 pandemic have afflicted, the similarity of early stage symptoms of the two diseases[7] might be subjected to misdiagnosis. So, it is very likely that the number of documented instances is understated.

Manifestation of dengue infection may be asymptomatic or symptomatic. Symptomatic cases may range from mild fever or classical dengue fever (DF) to severe illness in dengue hemorrhagic fever (DHF) or dengue shock syndrome (DSS)[8]. DF can be defined by a high body temperature (up to 40°C), severe headache, nausea and vomiting, severe joint and muscular pain, retro-orbital pain, and maculopapular rash[9,10]. Unusual hemorrhages, such as gastrointestinal bleeding, hypermenorrhea, and epistaxis (nose bleeding), can happen at any time[9]. Severe dengue manifests itself 1–2 days after the fever has subsided[10] and it can be characterized by DHF, symptoms of which are persistent vomiting, abdominal pain, epistaxis, hematemesis, melena, fatigue and restlessness. And if this is not properly managed it can lead to serious conditions like internal hemorrhage and death[10]. The increase in vascular permeability (plasma leakage) is a distinguishing characteristic of DHF[9, 11], the patients' blood pressure drops sharply which leads to DSS[10]. Sometimes there can be some unusual cases where severe organ impairment such as liver, kidneys, brain or heart impairment can occur from DHF which can be the result of coinfections, comorbidities or complications of prolonged shock. DHF can develop in people who are infected with the dengue virus for the first time, but the majority of DHF can be seen in a subsequent infection[10].

Dengue fever is usually transmitted in monsoon because during rainy season, the temperature and humidity remains ideal for the survival of adult and larval mosquitoes[12]. In Bangladesh, pre-monsoon rain during the months of May provide habitat for the vectors to lay eggs, then in monsoon vector number remains high and gradually decrease

afterwards[13]. But rainfall in winter or post-monsoon season can also create stagnant water bodies which are breeding grounds for *Aedes* mosquitoes[14]. Heavy rainfall, in the near term, destroys larvae and decreases female mosquito survival rates, but in the long run, it produces a plethora of breeding sources[15] by inundating artificial containers[16]. Conversely, very little rainfall, especially in arid areas or prolonged drought condition increases the storage of drinking water and the use of air-coolers, resulting in availability of more breeding grounds for the mosquito vector[15,16]. Aedes population size, reproduction, incubation and maturation period of larvae, feeding habits, and survival rate are also affected by temperature and humidity[15-17]. Increased temperature may result in shorter reproductive cycle of these mosquitoes with increased potency for offspring production[15,16]. Furthermore, though adult Aedes aegypti are less likely to survive at temperatures above 30°C[13], the extrinsic incubation period of dengue viruses decreases[12, 15]. In addition, small sized mosquitoes are also produced sometimes which may take more blood by biting human to produce eggs, resulting in a rise in the number of infected mosquitoes and fastening the disease outbreak[12,18]. Due to these increasing temperature, relative humidity and fluctuating seasonal rainfall, Bangladesh is facing a sharp rise in the number of dengue infection every year.

In Bangladesh, dengue fever treatment is mostly centered on supportive fluid therapy, as well as serological testing such as NS1 antigen, IgM and IgG levels, hematocrit (HCT) levels, reverse transcription PCR and platelet counts. The government of Bangladesh has implemented a variety of measures to reduce the *Aedes* mosquito population since the country's first dengue outbreak, such as raising awareness through media (TV, newspaper), seminars and volunteer organizations[19], thermal fogging, spraying larvicide[20], monitoring and removal of larval *Aedes* mosquito supplies[21] etc. Nonetheless, dengue cases in Bangladesh continue to climb every year. In this situation, in addition to reinforcing public health management efforts, regular surveillance has become extremely important, as surveillance provides an epidemiological picture of disease's transmission risk. This study was a cross sectional epidemiological survey among 533 dengue patients who were admitted in different hospitals of Dhaka in 2021 to observe and highlight the clinical manifestations of the dengue patients discerning the severity and to illustrate seasonal variation of dengue among the patients. This will help us to identify the changing pattern of clinical features and seasonal variation of dengue outbreak in recent years.

Materials and Methods

Study design: This cross-sectional survey was conducted among dengue patients admitted to different hospitals of Dhaka city in 2021. Surveying or data collection from dengue patients by face-to-face interview in the hospitals was not allowed because of COVID-19 situation. For this reason, contact number of dengue patients admitted in the hospitals at different areas of Dhaka city was collected from Directorate General of Health

Services (DGHS) upon request. Then patients were contacted and interviewed for dengue data over the phone.

Sample size: The Raosoft online sample size calculator was used to determine the minimum acceptable sample size[22]. We collected data of 533 patients in the current study to avoid any err.

Questionnaire format and data collection: Interview of the patients and data collection was done according to a pre-tested questionnaire. The questionnaire contained socio-demographic information of the patients (age, gender, family members, area of residence, family income) and clinical features. Clinical featured portion contained presence or absence of various clinical symptoms (high fever, headache, body pain, vomiting/nausea, skin rash, abdominal pain, pleural effusion, ascites, breathing problem, loose motion, loss of appetite, weakness, gum bleeding, melena, hematuria, mucosal bleeding, hematemesis etc.) as well as previous exposure to dengue, history of dengue among family members, and time of dengue infection. In case of child patients, their parents or guardians provided the necessary information. Solely those were interviewed who had given verbal consent prior the interview. Only the complete questionnaires of 533 patients were considered for the statistical analysis.

Statistical analysis: Descriptive statistics and chi-square (χ^2) test were used to analyze the data. Fisher's exact test was performed instead of chi-square test where the sample size was small. The statistical programing language R[23] has been used the statistical analysis.

Ethical clearance: Ethical approval was obtained from the Faculty of Biological Sciences, University of Dhaka ethical review committee and oral consent was taken from each participant prior to interview. Anonymity of the patients was strictly maintained.

Results and Discussion

A total of 533 dengue patients admitted in different hospitals of Dhaka city in 2021 were included in this study. Majority of the patients resided in DSCC (53.7%) followed by DNCC (43.9%) and areas of Dhaka outside city corporation (2.4%) (Table 1). The study by Abir *et al*. (2021) is similar in that there were more patients from DSCC than DNCC in that study[24]. This may be due to poor urban design, high population density, the constrained size of roads and inadequate drainage systems in DSCC that causes blockage during a severe downpour and the roads get flooded. *Aedes* breeding grounds are generated as a result.

It was also found that majority of the respondents (67.4%) had higher monthly household income (30001 ≥ BDT) (Table 1). People with higher income use air conditioner, and ornamental plants in pots or tubs in the house which can retain water for an extended period of time and serve as a habitat for *Aedes* mosquitoes to breed. Furthermore, high-income people's less exposure to unclean environments or conditions or germs than lower-

income people might make them more susceptible to diseases and this might be a reason for the higher proportion of dengue in higher income people.

Table 1: Socio-demographic characteristics of patients

Socio-demographic characteristics	Number of Patients	p-value
Area of residence		
Dhaka North City Corporation	234 (43.9%)	< 0.001
Dhaka South City Corporation	286 (53.7%)	
Areas of Dhaka outside city corporation	13 (2.4%)	
Monthly family income (BDT)		
≤ 10000	17 (3.2%)	< 0.001
10001-20000	63 (11.8%)	
20001-30000	84 (15.8%)	
30001 ≥	359 (67.4%)	
Not willing to tell	10 (1.9%)	
Family size (members)		
Small (1-5)	410 (76.9%)	< 0.001
Medium (6-10)	116 (21.8%)	
Large (10 >)	7 (1.3%)	

Family size was classified based on the number of family members. Families having 1-5 members, 6-10 members and 10 > members were classified as small, medium and large sized families respectively. Most of the respondents came from small sized families (76.9%) followed by medium (21.8%) and large sized families (1.3% : Table 1).

High fever, headache, body pain, vomiting/nausea were the most common symptoms found in majority of the patients (Fig. 1). Skin rash and eye lesion were reported in 33.6% and 26.1% patients. Weakness, loose motion, loss of appetite, abdominal pain was also found in 14.8%, 5.4%, 7.1%, 3.9% patients respectively.

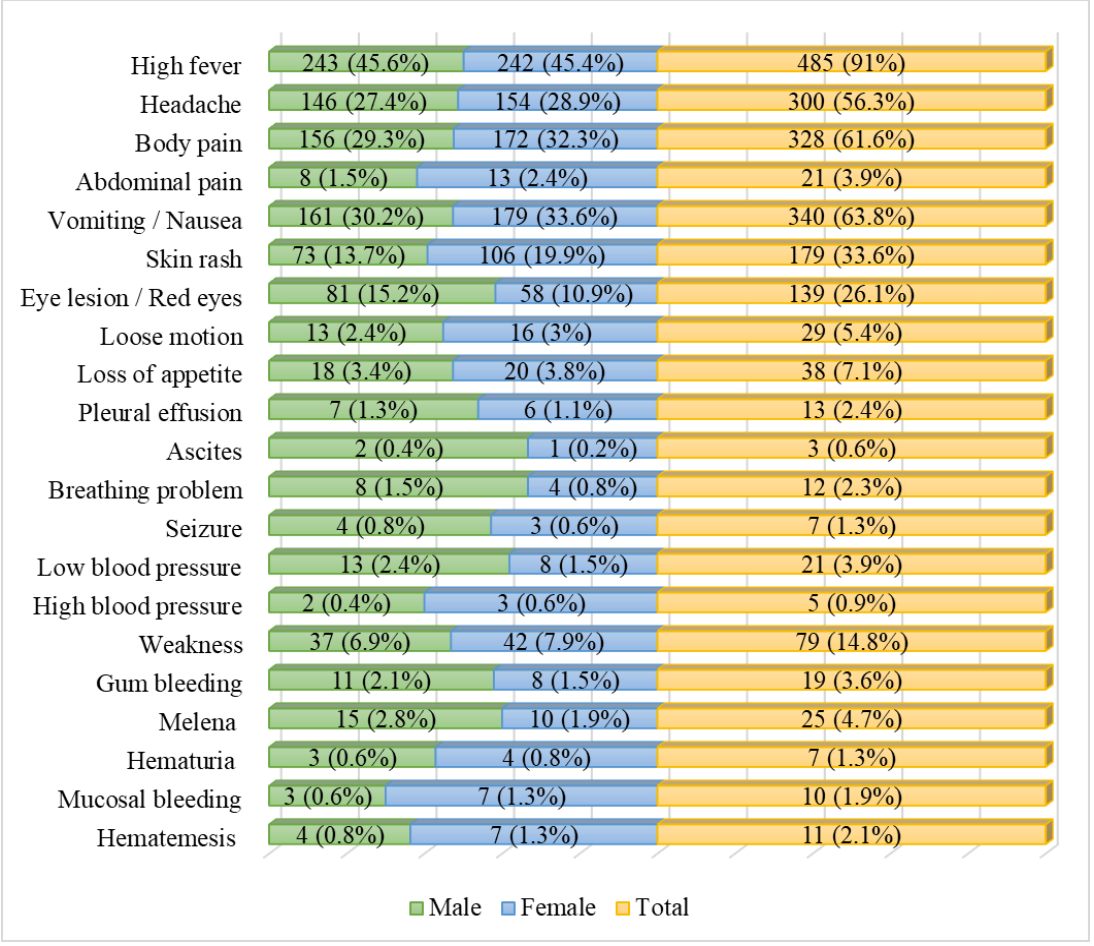

Fig. 1. Clinical manifestations of the patients.

Fever, headache, body pain, skin rash, vomiting/nausea- these are the most common symptoms that are typically seen in dengue patients and align with those found in related previous studies conducted in Dhaka[10,25-27]. But some symptoms and complications found in the current study such as eye lesion/red eyes, seizures etc. were less common in dengue patients previously in Bangladesh. Red eye was found among dengue patients of the year 2000[28], but not reported in the studies conducted in Dhaka in 2006, 2007, 2008, 2016, 2018[26-27,29]. This symptom was again evident in patients of 2019[30] and 2021. Moreover, seizures and loss of appetite were not reported in dengue patients of Dhaka previously up until 2019[10,25]. Low blood pressure was another complication found in 2021 dengue patients (3.9%) and not reported previously except in a study on 2019 dengue patients[30]. Breathlessness was first reported in dengue patients of Dhaka city in 2016[26]. Among bleeding manifestations, melena and gum bleeding were found to the most typical form in the present study. This is similar to the study conducted in 2019 by Hasan *et al*. (2021).

Although dengue is presented with varied symptoms every year, it is noticeable that severe conditions and complications are more prevalent in recent years than previous, especially from the year 2019. These emerging complications in dengue infection in recent years most likely imply a change in disease severity and was highlighted by a rise in the number of infections and mortality. Hasan *et al*. (2021) conducted a study on this topic and confirmed this change of severity in dengue cases[30]. The study held all epidemiological, environmental, virological matters and vector dynamics to be responsible for this change, and suggested to pursue research in all these fields in addition to clinical understanding.

Number of male and female participants was almost equal in this study (male- 269, female- 264). In terms of gender-based distribution of clinical manifestations, statistical analysis showed that vomiting/nausea ($\chi^2 = 3.886$, p=0.048), skin rash ($\chi^2 = 9.933$, p=0.002) and eye lesion/red eyes ($\chi^2 = 4.582$, p=0.032) were significantly associated with gender, where females were more likely to have vomiting/nausea and skin rash, and eye lesion/red eyes was more prevalent in males (Fig. 1).

Age of the patients were divided into six age groups. Figure 2 shows that frequency of suffering from high fever was almost equal for every age group and for both genders. Abdominal pain, pleural effusion, seizure, hematemesis- these were seen more in children (≤ 10 years old) than others. Upper respiratory symptoms and seizures were also found to be higher in children in a study of Thailand conducted by Taiwilai *et al*. (2017)[31]. On the contrary, headache and body pain was less common in patients of ≤10 years than the older patients. This finding also was consistent with the study of Thailand[31]. Among hemorrhagic manifestations, melena was found more or less common in every age group. So, it is evident that any age group could experience all severe dengue symptoms. In case of age groups, statistical analysis showed that high fever ($\chi^2 = 14.527$, p = 0.013), headache ($\chi^2 = 34.016$, p = 2.364e-06), body pain ($\chi^2 = 44.446$, p = 1.88e-08), vomiting/nausea ($\chi^2 = 15.483$, p = 0.0085), skin rash ($\chi^2 = 12.109$, p = 0.033), eye lesion/red eyes ($\chi^2 = 20.269$, p = 0.0011), pleural effusion (p = 0.0404), weakness ($\chi^2 = 13.822$, p = 0.017), and gum bleeding (p = 0.014) were significantly associated. Adults were more likely to complain about headache and body pain than children. Vomiting/nausea, skin rash, eye lesion/red eyes and gum bleeding were more frequently reported in the age group 21-30 years while weakness was more seen in the age group 31-40 years. Different symptoms reported by various age groups often correspond to age related physiological changes[32]. To make it easier to design appropriate management recommendations, it is helpful to be aware of and to monitor altering patterns of disease in various age groups.

A total of 462 patients (86.7%) reported thrombocytopenia (<150000 per microliter blood). 27% patients reported their lowest platelet count to be ≤ 20000 (Table 2). Almost one third patients (31.7%) had platelet count ranging from 20001-50000. 10 patients (1.9%) said that their platelet was in normal range, and 61 patients (11.4%) did not remember their platelet count (Table 2). Gender based distribution showed that lowest platelet count ≤20000 was mostly found in males (15.6%) (Table 2). Age based distribution showed that lowest

platelet count ≤ 20000, 20001-50000, and 50001-100000 were mostly seen in age group 31-40 years (5.8%), 41-50 years (6.2%) and 21-30 years (5.4%) respectively (Table 3). However, the association between platelet count and gender (Table 2) and between platelet count and age groups (Table 3) were not found significant (considering the category 'Do not remember' as missing values). The severity of dengue, including DHF and DSS, has been hypothesized to be related to thrombocytopenia[33]. The platelet count distribution and regular monitoring of platelet count may be utilized to forecast the course of the illness.

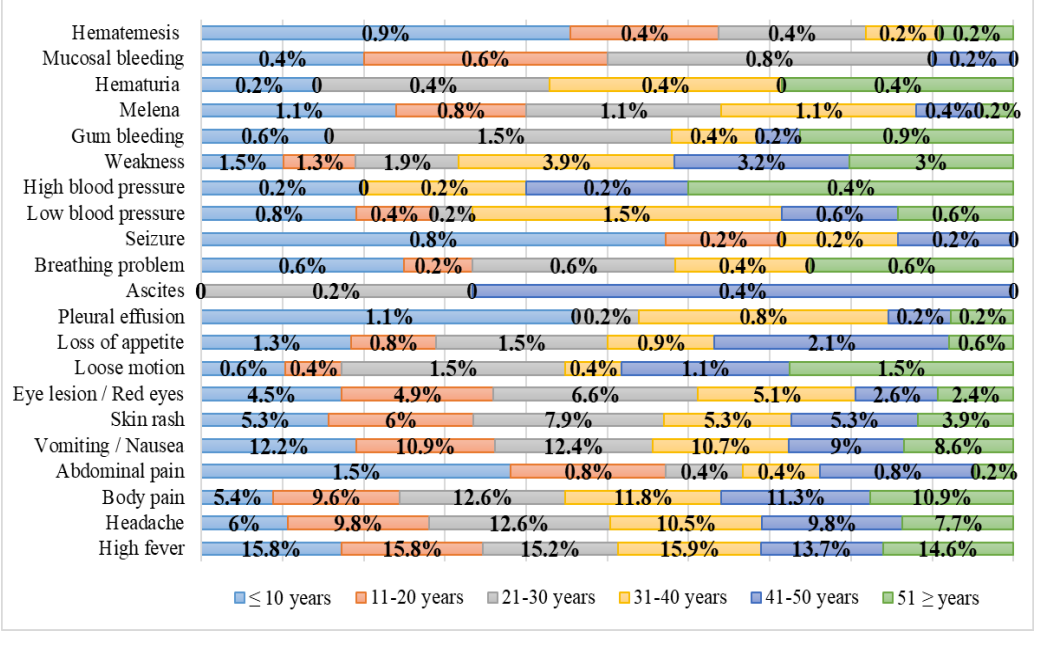

Fig. 2. Age-group based distribution of clinical manifestations.

Table 2: Distribution of patients by platelet count

Platelet count (lowest) (per microliter blood)	Number of patients	Male	Female	p-value
≤ 20000	144 (27%)	83 (15.6%)	61 (11.4%)	0.2272*
20001-50000	169 (31.7%)	79 (14.8%)	90 (16.9%)	
50001-100000	115 (21.6%)	60 (11.3%)	55 (10.3%)	
100001-150000	34 (6.4%)	14 (2.6%)	20 (3.8%)	
Normal (150000-450000)	10 (1.9%)	4 (0.8%)	6 (1.1%)	
Do not remember	61 (11.4%)	29 (5.4%)	32 (6%)	

* Fisher's exact test

Table 3: Age-group based distribution of platelet count

Platelet count (lowest) (per microliter blood)	**≤ 10 years**	**11-20 years**	**21-30 years**	**31-40 years**	**41-50 years**	**51 ≥ years**	**p-value**
≤ 20000	18 (3.4%)	25 (4.7%)	19 (3.6%)	31 (5.8%)	27 (5.1%)	24 (4.5%)	0.052
20001-50000	23 (4.3%)	27 (5.1%)	28 (5.3%)	29 (5.4%)	33 (6.2%)	29 (5.4%)	
50001-100000	21 (3.9%)	21 (3.9%)	29 (5.4%)	13 (2.4%)	13 (2.4%)	18 (3.4%)	
100001-150000	10 (1.9%)	4 (0.8%)	3 (0.6%)	8 (1.5%)	6 (1.1%)	3 (0.6%)	
Normal (150000-450000)	4 (0.8%)	1 (0.2%)	2 (0.4%)	0	0	3 (0.6%)	
Do not remember	14 (2.6%)	9 (1.7%)	8 (1.5%)	9 (1.7%)	10 (1.9%)	11 (2.1%)	

A total of 19 (3.6%) patients were admitted to the ICU due to serious condition (Table 4). Among them 12 were males and 7 were females. And out of 533 patients surveyed, 9 patients (1.7%) died of dengue where 6 were males and 3 were females (Table 4). Growing evidence suggests that biological variations including those based on genetic, immunological, and hormonal variables between males and females, might influence the clinical picture and disease risk[34]. Compared to males, females may produce a more robust immunological response to infection[35]. This can be the reason for male preponderance in case of dengue severity. The number of patients who died of dengue was significantly associated with age groups ($p < 0.05$). Among those who died and were admitted to ICU, majority were children (≤ 10 years). The reason behind this might be the lower immunity of children, decreased compensatory reserve and higher capillary fragility compared to the adult which cause the disease to become more severe[36]. Additionally, this finding implies that children or younger patients are more vulnerable than older ones.

Table 4: Distribution of patients admitted to the ICU / patients died of dengue

Age group	Number of patients admitted to the ICU	p-value	Number of patients died of dengue	p-value
≤ 10 years	6 (Male-3, Female-3)	0.339*	6 (Male-4, Female-2)	0.009*
11-20 years	5 (Male-4, Female-1)		1 (Male-1, Female-0)	
21-30 years	2 (Male-1, Female-1)		0	
31-40 years	3 (Male-2, Female-1)		0	
41-50 years	2 (Male-1, Female-1)		1 (Male-0, Female-1)	
51 ≤ years	1 (Male-1, Female-0)		1 (Male-1, Female-0)	
Total	19 (3.6%)		9 (1.7%)	

*Fisher's exact test

239 patients (44.6%) had family members who were also affected with dengue (Table 5). It can be assumed that the family members were infected at home. Family members congregating in a residence or dwelling increased the frequent exposure to mosquito bites. And those who did not have any affected family member can be assumed to have good preventive practice behavior to avoid dengue infection in the family.

The association between family size and patients with dengue affected family members was significant ($p < 0.05$) (Table 5). Of these 239 patients whose family members were also affected, majority were from small sized families (71%) followed by medium (28%) and large sized families (1%). The overall number of patients from small sized family was also far greater than that from medium and large sized families (Table 1). It is possible that this is the case because most of the families in Dhaka are typically small in size[37].

Table 5: Family size of the patients with dengue affected family members

Family size	Patients with dengue affected family members / Families with more than 1 dengue affected members	p-value
Small	170 (71%)	0.005337
Medium	67 (28%)	
Large	2 (1%)	
Total patients with dengue affected family members- 239 (44.8%)		

Among the 533 patients surveyed, monthly distribution showed that majority were infected from the month July followed by August, September (Fig. 3). Seasonal distribution

showed majority (65.29%) had dengue in the monsoon season followed by post-monsoon season (33.21%) (Fig. 3). This is consistent to the findings from earlier reported cases in Dhaka[38].

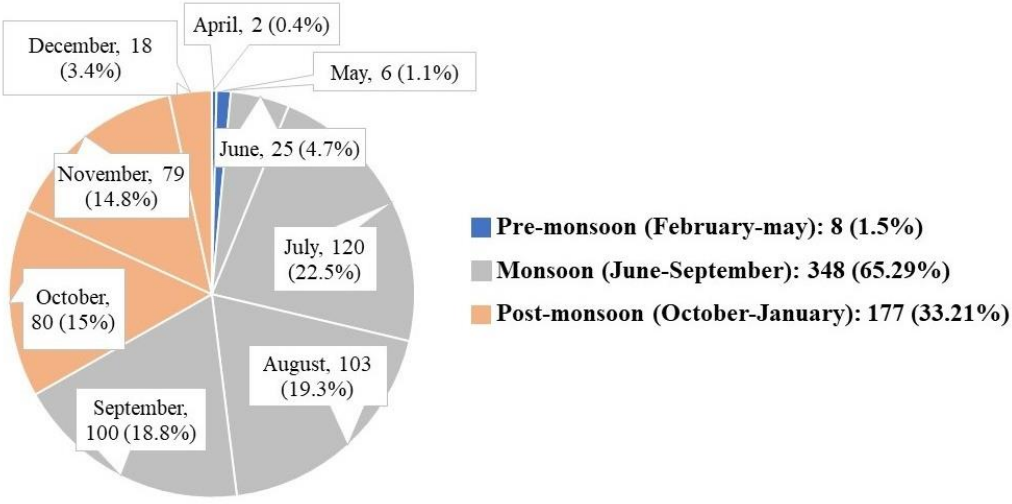

Fig. 3. Monthly and Seasonal variation of dengue occurrence among surveyed patients.

It was found that the occurrence of dengue was significantly associated with the season ($p<0.001$), where monsoon season had more dengue cases. This might be attributed to the unremitting rainfall in the monsoon season which increases the vector concentration. Sporadic rainfall after the monsoon season also contribute to the increasing number of dengue cases in the post-monsoon season. According to a study, dengue cases might rise by 8% for every 1 mm increase in precipitation[14]. Moreover, high humidity promotes adult mosquito lifespan and reduces the time needed for a virus to incubate, which leads to higher intensity of transmission[14].

A primary limitation of the study was that the study was limited only to dengue patients, for which prevalence of the disease could not be estimated. Secondly, as it was a telephone survey and face-to-face interview was not possible, laboratory profiles of the patients could not be included. Future research including the laboratory profiles are needed for accurate investigation.

To conclude, we can say from the study that dengue patients presented a variety of symptoms which were also non-specific in some cases. The clinical characteristic pattern in dengue is presently steadily changing from the past. In this situation, early disease identification and meticulous disease severity monitoring are essential for effective treatment. Also, in assessing the existing diagnostic and treatment approaches designed for the prevention of dengue outbreaks, epidemiological studies are imperative. So more future researches are requested regarding dengue fever surveillance and to identify the biomarkers linked to treatment of dengue.

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References

1. Mustafa MS, V Rasotgi, S Jain and V Gupta 2015. Discovery of fifth serotype of dengue virus (DENV-5): A new public health dilemma in dengue control. Med. J. Armed Forces India, **71**(1): 67-70
2. WHO, 2022. Dengue and severe dengue. Available from: https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue
3. Mutsuddy P, ST Jhora, AKM Shamsuzzaman, SMG Kaisar, MNA Khan and S Dhiman 2019. Dengue Situation in Bangladesh: An Epidemiological Shift in terms of Morbidity and Mortality. Can. J. Infect. Dis. Med. Microbiol. 2019
4. Paul KK, P Dhar-Chowdhury, CE Haque, HM Al-Amin, DR Goswami, MAH Kafi, MA Drebot, LR Lindsay, GU Ahsan and WA Brooks 2018. Risk factors for the presence of dengue vector mosquitoes, and determinants of their prevalence and larval site selection in Dhaka, Bangladesh. PloS one. **13**(6): e0199457
5. Mamun MA, JM Misti, MD Griffiths and D Gozal 2019. The dengue epidemic in Bangladesh: risk factors and actionable items. The Lancet. **394**(10215): 2149-2150
6. DGHS. Data. 2021. Available from: https://old.dghs.gov.bd/index.php/en/data
7. CDC. Available from: https://www.cdc.gov/dengue/is-it-dengue-or-covid.html
8. Low JGH, A Ong, LK Tan, S Chaterji, A Chow, WY Lim, KW Lee, R Chua, CR Chua, SWS Tan, YB Cheung, ML Hibberd, SG Vasudevan, LC Ng, YS Leo and EE Ooi 2011. The early clinical features of dengue in adults: Challenges for early clinical diagnosis. PLoS Negl. Trop. Dis. **5**(5): e1191
9. WHO 2011. Comprehensive guideline for prevention and control of dengue and dengue haemorrhagic fever.
10. Mahmood R, MS Benzadid, S Weston, A Hossain, T Ahmed, DK Mitra and S Ahmed 2021. Dengue outbreak 2019: clinical and laboratory profiles of dengue virus infection in Dhaka city. Heliyon, **7**(6): e07183
11. Kalayanarooj S 2011. Clinical manifestations and management of dengue/DHF/DSS. Trop. Med. Health, **39**(4 Suppl): 83–87
12. Kweka EJ, V Baraka, L Mathias, B Mwang'onde, G Baraka, L Lyaruu and AM Mahande 2019. Ecology of Aedes mosquitoes, the major vectors of Arboviruses in human population. Dengue Fever—A Resilient Threat in the Face of Innovation. IntechOpen; 2019. 39-56
13. Sharmin S, K Glass, E Viennet and D Harley 2015. Interaction of mean temperature and daily fluctuation influences dengue incidence in Dhaka, Bangladesh. PLoS Negl. Trop. Dis. **9**(7): 1–13

14. Islam MA, MN Hasan, A Tiwari, MA Raju, F Jannat, S Sangkham, MI Shammas, P Sharma, P Bhattacharya and M Kumar 2023. Correlation of Dengue and Meteorological Factors in Bangladesh: A Public Health Concern. Int. J. Environ. Res. Public Health. **20**(6): 5152
15. Hii YL, J Rocklöv, N Ng, CS Tang, FY Pang and R Sauerborn 2009. Climate variability and increase in intensity and magnitude of dengue incidence in Singapore. Glob. Health Action. **2**(1): 1–9
16. Banu S, W Hu, C Hurst and S Tong 2011. Dengue transmission in the Asia-Pacific region: Impact of climate change and socio-environmental factors. Trop. Med. Int. Health. **16**(5): 598–607
17. Yang HM, MLG Macoris, KC Galvani, MTM Andrighetti and DMV Wanderley 2009. Assessing the effects of temperature on the population of Aedes aegypti, the vector of dengue. Epidemiol. Infect. **137**(8): 1188–1202.
18. Scott TW, AC Morrison, LH Lorenz, GG Clark, D Strickman, P Kittayapong, H Zhou and JD Edman 2000. Longitudinal studies of Aedes aegypti (Diptera: Culicidae) in Thailand and Puerto Rico: Population dynamics. J. Med. Entomol. **37**(1): 77–88.
19. Hossain MI, Y Wagatsuma, MA Chowdhury, TU Ahmed, MA Uddin, SMN Sohel and P Kittayapong 2000. Analysis of some Socio-demographic Factors Related to DF/DHF Outbreak in Dhaka City. Dengue Bulletin. **24**: 34-41
20. Al-Amin HM, FT Johora, SR Irish, MRH Hossainey, L Vizcaino, KK Paul, WA Khan, R Haque, MS Alam and A Lenhart 2020. Insecticide resistance status of Aedes aegypti in Bangladesh. Parasites & Vectors. **13**: 1-15
21. Ahsan A, N Haider, R Kock and C Benfield 2021. Possible drivers of the 2019 dengue outbreak in Bangladesh: the need for a robust community-level surveillance system. J. Med. Entomol. **58**(1): 37-39
22. Raosoft (2004) Raosoft sample size calculator. Raosoft, Inc., Seattle. http://www.raosoft.com/ samplesize .html
23. R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.
24. Abir T, O Ekwudu, NA Kalimullah, DM Nur-A Yazdani, A Al Mamun, P Basak, UL Osuagwu, PP Yukthamarani, AH Milton, SH Talukder and KE Agho 2021. Dengue in Dhaka, Bangladesh: Hospital-based cross-sectional KAP assessment at Dhaka North and Dhaka South City Corporation area. PLoS ONE, **16**(3 March): 1–17
25. Khan MAS, A Al Mosabbir, E Raheem, A Ahmed, RR Rouf, M Hasan, FB Alam, N Hannan, S Yesmin, R Amin, N Ahsan, S Anwar, S Afroza and MS Hossain 2021. Clinical spectrum and predictors of severity of dengue among children in 2019 outbreak: a multicenter hospital-based study in Bangladesh. BMC Pediatrics. **21**(1): 1–10
26. Mobarak MR, MR Islam, AT Bhuiyan, N Akand and F Begum 2017. Evaluation of Dengue Fever in a tertiary care children hospital of Bangladesh. Northern Int. Med. College. J. **9**(1): 274-277
27. Sultana N, N Fatema, MZ Hossain, MA Rahman, N Nehar, MM Yeasmin, R Sharmin, AA Sweety and M Pervin 2019. Frequency of dengue infection in febrile patients attended Dhaka Medical College Hospital during January to December, 2018. J Dhaka Med. College. **28**(1): 105-111
28. Yunus EB, AM Bangali, M Mahmood, MM Rahman, AR Chowdhury and KR Talukder 2001. Dengue Outbreak 2000 in Bangladesh: From Speculation to Reality and Exercises.

29. Alam AS, SA Sadat, Z Swapan, AU Ahmed, MN Karim, HK Paul and S Zaman 2009. Clinical profile of dengue fever in children. Bangladesh J Child Health. **33**(2): 55-58

30. Hasan MJ, T Tabassum, M Sharif, MAS Khan, AR Bipasha, A Basher, MR Islam and MR Amin 2021. Comparison of clinical manifestation of dengue fever in Bangladesh: an observation over a decade. BMC Infect. Dis. **21**: 1-10

31. Tiawilai A, T Tiawilai and U Thisyakorn 2017. Manifestations of dengue in various age groups of Thai children and adults: a cross sectional study. Southeast Asian J. Trop. Med. Public Health. **48**(Suppl 1): 122-127

32. Trung DT, LTT Thao, NM Dung, TV Ngoc, TT Hien, NVV Chau, M Wolbers, DTH Tam, J Farrar, C Simmons and B Wills 2012. Clinical features of dengue in a large Vietnamese cohort: intrinsically lower platelet counts and greater risk for bleeding in adults than children. PLoS Negl. Trop. Dis. **6**(6): e1679.

33. Tee HP, SH How, AR Jamalludin, MN Safhan, MM Sapian, YC Kuan and S Sapari 2009. Risk factors associated with development of dengue haemorrhagic fever or dengue shock syndrome in adults in Hospital Tengku Ampuan Afzan Kuantan. Med. J. Malaysia. **64**(4): 316-320.

34. Aamir M, G Masood, W Aamir, A Rasheed, A Ejaz and S Syed 2014. Gender difference in patients with dengue fever admitted in a teaching hospital, Lahore. Pak. J. Med. Health Sci. **8**(1): 12-15

35. Klein SL 2000. The effects of hormones on sex differences in infection: from genes to behavior. Neurosci. Biobehav. Reviews. **24**(6): 627-638

36. Whitehorn J and CP Simmons 2011. The pathogenesis of dengue. Vaccine. **29**(42): 7221-7228

37. Preliminary Report on Population and Housing Census 2022. Available from: http://www.bbs.gov.bd/site/page/b588b454-0f88-4679-bf20-90e06dc1d10b/-

38. Morales I, H Salje, S Saha and ES Gurley 2016. Seasonal distribution and climatic correlates of dengue disease in Dhaka, Bangladesh. Am. J. Trop. Med. Hyg. **94**(6): 1359.

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