**Spreading out of Severe Dengue: Clinico-laboratory Characteristics and Comorbidities in Dhaka City**

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**Abstract**

**Background**: Dengue incidence in Bangladesh has spread, resulting in the deadliest outbreak in 2023 and continued high levels in 2024. Despite aggressive control measures, dengue persists, especially in Dhaka city, where there has also been a rise in comorbidities and new symptoms. Laboratory and clinical characteristics are evaluated to detect severe dengue infections early and treat the illness effectively, particularly in areas where transmission is prevalent.

**Methods**: A corresponding retrospective case-control study was conducted on 435 dengue patients admitted to different medical college hospitals in Dhaka between January and June 2024. Univariate and multivariable logistic regression was conducted to identify predictors of disease severity using demographic and clinical dengue data.

**Results**: Among the patients, 60.92% were male, and 53.16% were under 30. Comorbidities like diabetes (AOR: 2.79; 95% CI: 1.84–3.15) and hypertension (AOR: 2.67; 95% CI: 1.23–5.63) were significantly associated with severe dengue. Symptoms such as abdominal pain (AOR: 1.97), vomiting (AOR: 1.68), and headache (AOR: 1.36) also indicated increased severity. Severe dengue cases had elevated hematocrit, serum creatinine, AST, ALT, pulse rate, and length of stay, while white blood cell count, platelet count, and albumin levels were lower.

**Conclusions**: Significant clinical and biochemical differences between patients with severe and non-severe dengue were found in this investigation. Severe dengue was significantly predicted by comorbid conditions including diabetes and hypertension as well as symptoms like vomiting and stomach discomfort. These findings suggest that patients with these risk factors require closer monitoring to reduce morbidity and mortality. Larger studies are needed to validate these results.

***Keywords:* Case-control, Dengue, Retrospective Study, Severe dengue, Bangladesh,**

**Introduction**

Humans contract dengue, a virus spread by the dengue virus (DENV), when bitten by an infected mosquito (1). Dengue fever is prevalent in urban and semi-urban environments within tropical and subtropical regions, posing a threat to over 50% of the global population (2). This emergence highlighted the disease's growing impact, particularly in tropical and subtropical areas where the Aedes mosquito vectors thrive (3,4). Globally, only in 2024, from January to December, a total 14,284,310 cases and 10,554 deaths were identified according to WHO Global dengue surveillance (5). The incidence of dengue fever is mostly found in 128 countries, including Southeast Asia, Eastern Mediterranean, and the Western Pacific (6). The two primary dengue virus circulation hotspots in 2023 are South America and South and Southeast Asia (7). Alike other tropical and sub-tropical countries, dengue fever is a serious public health concern in Bangladesh.

As East Pakistan, Bangladesh experienced its initial dengue outbreak in 1964, coinciding with the introduction of the term "Dacca fever." In recent years, Bangladesh has been notably affected by dengue viruses and stands among the nation’s most significantly impacted (8). Official government monitoring systems have documented fatalities corresponding to significant outbreaks. In 2019, Bangladesh faced a widespread dengue epidemic, with 101,354 recorded cases and 164 deaths attributed to dengue (9). However, in 2024, the Ministry of Health & Family Welfare in Bangladesh has officially reported 101,214 laboratory-confirmed dengue cases and 575 associated deaths (10). From the initial decade (2000–2010) to the subsequent one (2011–2022), there has been an 8.3-fold surge in dengue cases, coupled with a 2.2-fold rise in annual fatalities in Bangladesh (11). This pattern disproportionately affected males and predominantly impacted individuals in the younger age groups (12). While Dhaka, historically the most severely affected division, has experienced a high number of cases, has seen the highest number of cases ever recorded outside Dhaka, comprising 64.82% (n=193,216) of the total cases. Dhaka still has a notable number of dengue-related deaths, with 980 reported and a case fatality rate of 0.89%, compared to 0.34% (deaths = 725) outside Dhaka (13). The country has been marked by unusually high temperatures, intolerable humidity, irregular rainfall, and a significant prevalence of dengue cases, contributing to an increase in mosquito populations nationwide (14,15).

Earlier reports described illnesses exhibiting clinical features consistent with dengue fever (16). Most people with dengue don't show symptoms, but common signs include high fever, headache, body aches, nausea, and rash. Most recover in 1-2 weeks, but some may develop severe dengue and require hospital care, which can be fatal (17). Identifying patients transitioning from mild to severe disease can be challenging, but it is a serious concern since proper care can prevent the development of more severe clinical conditions (17). Consistent diagnoses of dengue infections and campaigns can be considered efficacy in substantially decreasing mortality rates (18). Unfortunately, it seems that the authorities are not paying enough attention to the difficulty. This was evidenced by the absence of extensive public health awareness campaigns. It is imperative to urgently initiate campaigns, with a specific focus on early detection and the provision of supportive clinical management. Ensuring prompt access to appropriate care for dengue patients through primary healthcare providers can lower fatality rates to approximately 1% while also minimizing unnecessary hospitalizations (19).

Nevertheless, there is a paucity of literature delving into the interplay between demographic profiles, clinical features, comorbidities, and the prognosis/complications of dengue in Bangladesh in recent outbreaks. It seems like the topic is not so focused after 2019 outbreaks but in last years the dengue surpass the previous all records cumulatively in last year from 2000, demands more research on this issue to make attention to the policy makers. Grasping this relationship holds paramount importance in pinpointing high-risk dengue patients. The utilization of diverse warning indicators can play a pivotal role in promptly identifying potentially severe cases, facilitating timely treatment, averting unnecessary hospitalizations, and mitigating the case fatality rate of the disease. Hence, the primary aim of this study is to investigate the association between various clinical and laboratory characteristics, and comorbidities with severe cases of dengue on 2024 dengue patients.

**Materials and Methods**

We adhered to the STROBE guideline for reporting case-control studies in epidemiology (Table S1).

**Study settings**

This study was carried out at four government hospitals (Dhaka Medical College Hospital, Shaheed Suhrawardy Medical College and Hospital, Mugda Medical College Hospital, and Mohakhali DNCC hospital) of Dhaka city of Bangladesh during over the peak months of dengue outbreaks (July’2024 to December’ 2024) from dengue patients, dedicated to providing healthcare support to Dengue patient in Dhaka. The study area selected Dhaka city due to Dhaka city is the high dengue burden districts of the Bangladesh, which contributes to more than 40% of the total cases among all cases of the country, according to 2024 database. Details of the distribution of dengue has been provided elsewhere (10).

**Sampling design and sample size**

The study was designed for a total of 435 patients, with 145 designated as cases and 290 as control to compare the variables aimed to explore the possible risk factors associated with severe dengue fever. All cases were confirmed dengue patients diagnosed by antigen (NS1) test and were admitted to selected hospital until the sample collection completed. Whereas 145 patients were severe patients and defined as cases and 290 patients defined as controls were non-severe dengue patients and selected through frequency matching by age, gender, and geographic locations.

This research enrolls participants aged 18 years and above who have been diagnosed with severe and non-severe dengue patients as per the 2009 Dengue Classification outlined by the World Health Organization (17). To ensure clarity, it's important to note that all severe dengue cases in our study underwent treatment in the intensive care unit at designated research sites. The control group comprises adults aged 18 years and older diagnosed with non-severe dengue, who did not advance to severe dengue during their hospital stay. Individuals with non-severe dengue in the control group receive treatment in a specified general medical ward at our research site. Pregnant patients with dengue will be excluded from the study.

**Data collection**

Medically trained research assistants performed data extraction, which was followed by rule-based validation for the entire dataset by health professionals. Hospital electronic medical records were used to extract administrative, laboratory, microbiological. Additionally, 10% of the cases were randomly selected for repeat data entry by another research assistant, and any discrepancies were addressed through an independent review of medical case notes by one of the authors. The extracted data was de-identified for analysis. A pretested and standardized questionnaire was utilized, and all clinical records were reviewed by health professionals.

**Variables**

***Outcome variables:***

To construct our outcome variable indicating severity level, patients were designated as 1 or “yes” for “severe” dengue and for “non-severe” dengue 0 or “no” was defined. The creation of outcome variable based on severe and non-severe dengue patients as per the 2009 Dengue Classification outlined by the World Health Organization (17), derived from the hematology/biochemical test reports of the patients, and a thorough review of all records was conducted by medical specialists.

***Independent variables:***

Numerous potential risk factors associated with severe dengue have been explored, encompassing demographic details such as age, gender, marital status, education level, and monthly income. Additionally, pre-existing medical conditions including obesity, diabetes, hypertension, chronic pulmonary disease, and ischemic heart disease were investigated. The study also considered presenting signs and symptoms upon admission, such as abdominal pain, diarrhea, vomiting, lethargy, headache, rash, chills and/or rigor, nausea, hemorrhage, and musculoskeletal pain. According to the WHO Guidelines, obesity was defined as having a body mass index (BMI) of 27.5 kg/m2 or higher, based on admission data (20).

**Statistical Analysis**

For categorical variables were expressed in numbers and percentages while continuous variables were expressed in median and interquartile range (IQR). To examine the relation, we used bivariate analyses (chi-square test) for categorical variables and Wilcoxon rank-sum test (Mann-Whitney U test) for continuous variables. To examine the relationship between severe dengue and its associated risk factors, we conducted univariate [unadjusted] logistic regression models. We used all potential covariates in univariate models. We used an arbitrary p-value of ≤ 0.20 as a criterion to include covariates in the multivariable models (21). To choose the best model, we followed stepwise procedures. As a result, all significant covariates as well as a few important outcome-related factors were included in our final model. In univariate analyses, each variable is individually incorporated into the logistic regression model, presenting a crude odds ratio (COR). The multivariable logistic regression model was utilized to present an adjusted odds ratio (AOR), accounting for multiple variables simultaneously. All tests were performed at the 5% level of significance with a crude odds ratio (COR) or adjusted OR (AOR), p-value, and 95% confidence interval (CI) shown in tables, respectively.

**Variable Selection**

To assess multicollinearity in the final model, we employed a cut-off value of 4.00 for the variance inflation factor (VIF), following the methodology outlined by (22). All variables were included in this stage of the model, as each variable's VIF value was below 4.00.

**Model evaluation**

To evaluate the precision of the optimal model, we employed several metrics, including the Hosmer-Lemeshow goodness-of-fit test and the Area under the Receiver Operating Characteristic (AUROC). Enhanced model performance is reflected by higher AUROC values. Within the ROC curve, a reduced P-value signifies the model's effective discrimination between two categories, with an area under the curve surpassing 0.50 indicative of superior discrimination (23). The Hosmer-Lemeshow goodness-of-fit test evaluates the similarity between model-estimated probabilities and observed outcomes. Typically assessed through a goodness-of-fit test, a Hosmer-Lemeshow test yielding a P-value above 0.05 indicates the model's effectiveness in precisely categorizing observations into outcome categories (24).

**Ethical Considerations**

We conducted this study in accordance with human subject research guidelines set forth in the Declaration of Helsinki 1964 and its later amendments. Patient verbal consent was taken accordingly, and they were informed about the study’s objectives before commencing the data collection. Verbal permission was collected from the respective authority before proceeding the data collection.

**Results**

This study comprised 145 cases and 290 controls who were hospitalized in the selected hospitals., our study site, between January 1 to June 30, 2024. In this case-control study with a case-to-control ratio of 1:2, the cases included 75 (51.72%) males and 70 (48.28%) females, while the control group consisted of 190 (65.5%) males and 100 (34.5%) females. Regarding age, 60 (43.48%) cases were in the 0-29 years category, and 78 (56.52%) were greater than 29 years. In the cases group, 85 (59.44%) were married, and 58 (40.56%) were unmarried. Significant associations were observed between cases and controls concerning age, gender, and marital status (p<0.05). No discernible differences were found in dengue severity concerning education level and monthly income (p>0.05). However, a small portion of the cases had higher secondary and above education (4.96%), while the majority had primary education (41.13%)presented in Table 1.

Five comorbidities-obesity, diabetes, hypertension, chronic pulmonary diseases, and ischemic heart disease were compared in the study. Cases were much more likely than controls to have diabetes, ischaemic heart disease, and chronic pulmonary illness (p<0.05). Diabetes, chronic pulmonary disease, and ischaemic heart disease were present in 11 (7.59%), 23 (15.86%), and 14 (9.66%) of the patients in the cases group, respectively. Additionally, there was a strong correlation (p<0.05) between severe dengue patients and symptoms like lethargy, vomiting, diarrhoea, and abdominal discomfort. Abdominal pain, diarrhoea, vomiting, fatigue, and nausea symptoms were reported by 84 (58.3%), 33 (22.80%), 14 (9.66%), 28 (19.44%), and 27 (18.62%) patients in the cases group, respectively Table 1.

The median values for age (median=32), hematocrit (49.62), serum creatinine (132.11), aspartate aminotransferase (AST) (171.13), alanine transaminase (ALT) (123.17), pulse rate (89.68), temperature (38.68), and length of hospital stay (5.12) were significantly higher in the cases compared to the controls. In contrast, white blood cell count (4.90), platelet count (85.54), total bilirubin (10.34), total protein (62.74), albumin (39.78), and globulin levels (24.72) were significantly lower in the cases than in the controls presented in Table 2.

Table 3 presents information on the Crude Odds Ratio (COR) and Adjusted Odds Ratio (AOR) for the association between various factors and dengue severity. Results indicate that patients older than 29 years were more likely to experience severe dengue (COR: 1.82; 95% CI: 1.20-2.78), and after adjusting the model, this likelihood remained (AOR: 1.34; 95% CI: 1.12-4.72) compared to patients aged 29 years or younger. Female patients (COR: 1.77; 95% CI: 1.18-2.66) and married patients (COR: 2.04; 95% CI: 1.36-3.08) were also more likely to have severe dengue in the unadjusted model, but these associations became insignificant in the adjusted model.

The univariate logistic regression analysis revealed a statistically significant association between severe dengue and diabetes. Severe cases exhibited 1.62 times higher odds (COR: 1.62; 95% CI: 1.10-3.65) in the unadjusted model and 2.79 times higher odds (AOR: 2.79; 95% CI: 1.84-3.15) in the adjusted model compared to individuals without diabetes. Similarly, severe dengue cases had 2.19 times higher odds (COR: 2.19; 95% CI: 1.18-4.07) and 1.61 times higher odds (COR: 1.61; 95% CI: 1.17-3.34) in the unadjusted model for chronic pulmonary disease and ischemic heart disease, respectively. However, these associations were not significant in the adjusted model.

Comparing different clinical signs and symptoms between cases and controls, univariate and multivariable analyses identified abdominal pain as a higher odds and significant predictor of severe dengue (COR: 2.39; 95% CI: 1.60-3.61 and AOR: 1.97; 95% CI: 1.15-2.85). Although diarrhea and nausea were significant predictors in the crude model (COR: 1.41; 95% CI: 1.18-1.78 and COR: 2.06; 95% CI: 1.16-3.64, respectively), they became insignificant in the adjusted model. Vomiting and lethargy remained significant in both crude and adjusted models. In the adjusted model, severe dengue cases had higher odds of 1.68 (COR: 1.68; 95% CI: 1.03-2.19) and 1.55 (COR: 1.55; 95% CI: 1.01-2.22) for vomiting and lethargy, respectively, compared to their counterparts. Additionally, severe dengue cases had 1.36 times higher odds (COR: 1.36; 95% CI: 1.14-2.65) in the adjusted model than individuals without headache.

As per the Variance Inflation Factor (VIF) analysis, all variables exhibit values less than 5, indicating the absence of multicollinearity in the dataset. Moreover, the AUC value of 72.46% in Table 4 suggests that the classification accuracy is deemed acceptable in Figure 1. Additionally, the model successfully passed the Hosmer and Lemeshow goodness-of-fit test value is 10.46 with degrees of freedom 8 (P= 0.234), signifying no lack of fit in the model.

**Discussion**

This study evaluated the risk factors associated with severe dengue among 145 cases and 290 controls hospitalized during the 2024 dengue outbreak in Bangladesh. Our study aimed to identify risk factors for severe dengue during this outbreak, revealing a complex interplay of demographic characteristics, comorbidities, and symptoms. The findings underscore the significance of demographic factors, comorbidities, and clinical symptoms in predicting the severity of dengue, aligning with prior studies while offering fresh insights into the Bangladesh-specific context.

A significant relationship between age and dengue severity was observed, with individuals aged over 29 years being more susceptible to severe outcomes. This finding is consistent with previous research highlighting the vulnerability of older populations to severe dengue complications. The physiological changes with aging, such as weakened immune responses, may partly explain this increased risk (25,26). Interestingly, while more males were affected in both cases and controls, females showed higher odds of severe dengue in the unadjusted analysis, which consistent with earlier literature that men are more susceptible to dengue infection during outbreaks, while women are more associated with severe cases in Bangladesh (27–29) and other countries (30,31). Sex-specific discrepancies may be linked to differences in healthcare-seeking behavior, visitation patterns, and types of care. However, this effect became non-significant after adjusting for other factors, suggesting that while gender may influence dengue infection rates, it does not independently predict severity.

Our study reinforced the established role of comorbid conditions such as diabetes, chronic pulmonary disease, and ischemic heart disease in escalating the risk of severe dengue. Particularly, diabetes emerged as a strong predictor of severe outcomes, with an adjusted odds ratio of 2.79. This aligns with global studies that emphasize diabetes as a critical risk factor due to its impact on immune modulation and endothelial dysfunction, which can exacerbate the complications associated with dengue (30,31) and previous studies in Bangladesh (2,27). Chronic pulmonary disease and ischemic heart disease, while significant in univariate analysis, did not retain their independent predictive power in multivariate analysis. This highlights the need for more nuanced research into the specific mechanisms by which these conditions interact with dengue pathophysiology.

Abdominal pain, vomiting, and lethargy were significantly associated with severe dengue in both crude and adjusted models. These symptoms have long been recognized as warning signs for progression to severe dengue Abdominal pain showed a strong association with severe outcomes, which is consistent with previous findings suggesting that it is a marker of plasma leakage and impending shock (32–34). Conversely, the presence of headache was associated with lower odds of severe dengue, which is an intriguing finding corroborated by recent studies suggesting that headache may inversely correlate with disease severity. In a retrospective cohort study conducted in Singapore, involving 82 patients with dengue hemorrhagic fever (DHF) and 1855 patients with dengue fever, it was reported that the presence of headache upon presentation was linked to reduced odds of developing DHF (35).

The acceptable classification accuracy of 72.46% and the passing of the Hosmer-Lemeshow test suggest that our model is robust in identifying the predictors of severe dengue. The absence of multicollinearity further supports the reliability of these findings. However, while the model performs well in classifying patients, it leaves room for improvement, particularly in accounting for factors beyond demographic and clinical parameters, such as vector exposure and environmental conditions in present outbreak.

The results of this study highlight the importance of targeted public health interventions, especially for older adults and individuals with comorbidities. Tailored dengue awareness and prevention campaigns that emphasize the risk of severe outcomes in these populations are crucial. Additionally, healthcare systems should ensure prompt and aggressive management of patients presenting with warning signs like abdominal pain and vomiting to mitigate the risk of severe dengue complications. Gender differences in healthcare access and outcomes, as highlighted by the excess severe cases among females, also warrant further exploration to address potential disparities in care delivery.

Beyond the current significance, this study is limited to conducting at a single site, which may lack the generalizability of the findings. Additionally, due to the retrospective design, we were reliant on existing records, which may not have captured all relevant risk factors or comorbid conditions. Future studies should aim to include multiple centers and prospective designs to confirm these findings and explore additional risk factors for severe dengue.

**Conclusion**

In summary, our comprehensive case-control investigation underscores the significance of integrating socio-economic variables such as age, gender, and marital status, as well as comorbidities like diabetes and chronic pulmonary disease, along with key signs and symptoms such as abdominal pain, diarrhea, vomiting, and lethargy, in assessing the severity of dengue cases. This research contributes novel insights to the identification of crucial risk factors associated with severe dengue, enhancing our understanding of early detection and treatment. Future studies should delve deeper into the progression from non-severe to severe dengue, building upon the findings of this research.

**Data Availability Status:** Data will be available from the corresponding author upon request.

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**Conflicts of Interest:** The authors declare no conflicts of interest.

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**Author’s Contributions**

**KF:** Writing – review & editing

**MNH:** Formal analysis, Investigation, Methodology, Project administration, Software, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing

**MNA:** Supervision, Data curation, Investigation

**MH:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing

**MRH, MNH:** Formal analysis, Investigation, Methodology, Project administration, Software, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing

**SB, FJ, SA:** Formal analysis, Software, Visualization, Writing – review & editing

**SR, ANA:** Data curation, Investigation, Validation, Writing – review & editing

**KFF:** Supervision, Writing – review & editing

[Conceptualization, Data curation, Investigation, Methodology, Project administration]

**References**

1. WHO. Dengue: a mosquito-borne disease [Internet]. 2018. Available from: https://www.who.int/bangladesh/news/detail/28-05-2018-dengue-a-mosquito-borne-disease

2. Bhowmik KK, Ferdous J, Baral PK, Islam MS. Recent outbreak of dengue in Bangladesh: A threat to public health. Health Sci Rep [Internet]. 2023 Apr 11 [cited 2024 Oct 8];6(4): e1210. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10090488/

3. WHO. Dengue and severe dengue [Internet]. 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue

4. Gubler DJ. Dengue and dengue hemorrhagic fever. Clin Microbiol Rev. 1998 Jul;11(3):480–96.

5. Ong EP, Obeles AJT, Ong BAG, Tantengco OAG. Perspectives and lessons from the Philippines’ decades-long battle with dengue. Lancet Reg Health West Pac. 2022 Jul;24:100505.

6. Urcuqui-Inchima S, Patiño C, Torres S, Haenni AL, Díaz FJ. Recent developments in understanding dengue virus replication. Adv Virus Res. 2010;77:1–39.

7. Limkittikul K, Brett J, L’Azou M. Epidemiological Trends of Dengue Disease in Thailand (2000–2011): A Systematic Literature Review. PLoS Negl Trop Dis [Internet]. 2014 Nov 6 [cited 2024 Oct 16];8(11):e3241. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4222696/

8. WHO. HIV/AIDS in the South-East Asia Region : March 2007 [Internet]. 2007 [cited 2024 Oct 16]. Available from: https://iris.who.int/handle/10665/205303

9. Haider N, Hasan MN, Onyango J, Asaduzzaman M. Global Landmark: 2023 Marks the Worst Year for Dengue Cases with Millions Infected and Thousands of Deaths Reported. IJID Regions [Internet]. 2024 Sep 26 [cited 2024 Oct 16];100459. Available from: https://www.sciencedirect.com/science/article/pii/S2772707624001309

10. Sharmin S, Viennet E, Glass K, Harley D. The emergence of dengue in Bangladesh: epidemiology, challenges and future disease risk. Trans R Soc Trop Med Hyg. 2015 Oct;109(10):619–27.

11. Ullah MA, Mim AS, Hasan MN, Sadik MR. Deep Learning Based Forecasting Models of Dengue Outbreak in Bangladesh: Comparative Analysis of LSTM, RNN, and GRU Models Using Multivariate Variables with a Two-Decade Dataset. In: 2024 International Conference on Smart Systems for applications in Electrical Sciences (ICSSES) [Internet]. 2024 [cited 2024 Oct 16]. p. 1–6. Available from: https://ieeexplore.ieee.org/document/10561382

12. ReliefWeb. Bangladesh Dengue Situation 2019 Health Bulletin [Internet]. 2019 Jul [cited 2024 Oct 16]. Available from: https://reliefweb.int/report/bangladesh/bangladesh-dengue-situation-2019-health-bulletin-volume-1-27-july-2019

13. Haider N, Hasan MN, Khalil I, Tonge D, Hegde S, Chowdhury MAB, et al. The 2022 dengue outbreak in Bangladesh: hypotheses for the late resurgence of cases and fatalities. J Med Entomol. 2023 Jul 12;60(4):847–52.

14. Haider N, Asaduzzaman M, Hasan MN, Rahman M, Sharif AR, Ashrafi SAA, et al. Bangladesh’s 2023 Dengue outbreak - age/gender-related disparity in morbidity and mortality and geographic variability of epidemic burdens. Int J Infect Dis. 2023 Nov;136:1–4.

15. Islam S, Hasan MN, Kalam SB, Islam MS, Hasan MJ, Sami CA, et al. Clinical Profile, Severity Spectrum, and Hospital Outcome of Dengue Patients in a Tertiary Care Hospital in Dhaka City. Cureus [Internet]. 2022 [cited 2024 Oct 8];14(9):e28843. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9536477/

16. Hasan M, Khalil M, Chowdhury MAB, Rahman M, Asaduzzaman M, Billah M, et al. Two Decades of Endemic Dengue in Bangladesh (2000-2022): Trends, Seasonality, and impact of Temperature and Rainfall Patterns on transmission dynamics. 2023.

17. Islam MdA, Hasan MN, Tiwari A, Raju MdAW, Jannat F, Sangkham S, et al. Correlation of Dengue and Meteorological Factors in Bangladesh: A Public Health Concern. Int J Environ Res Public Health [Internet]. 2023 Mar 15 [cited 2024 Oct 16];20(6):5152. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10049245/

18. Pilot E, Nittas V, Murthy GVS. The Organization, Implementation, and Functioning of Dengue Surveillance in India—A Systematic Scoping Review. Int J Environ Res Public Health [Internet]. 2019 Feb [cited 2024 Oct 16];16(4):661. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6407027/

19. Yeh CY, Chen PL, Chuang KT, Shu YC, Chien YW, Perng GC, et al. Symptoms associated with adverse dengue fever prognoses at the time of reporting in the 2015 dengue outbreak in Taiwan. PLOS Neglected Tropical Diseases [Internet]. 2017 Dec 6 [cited 2024 Oct 16];11(12):e0006091. Available from: https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0006091

20. Cuschieri S. The STROBE guidelines. Saudi Journal of Anaesthesia [Internet]. 2019 Apr [cited 2024 Oct 16];13(Suppl 1):S31. Available from: https://journals.lww.com/sjan/fulltext/2019/13001/the\_strobe\_guidelines.9.aspx

21. Raosoft. Sample Size Calculator by Raosoft, Inc. [Internet]. 2024 [cited 2024 Oct 18]. Available from: http://www.raosoft.com/samplesize.html

22. Badawi A, Velummailum R, Ryoo SG, Senthinathan A, Yaghoubi S, Vasileva D, et al. Prevalence of chronic comorbidities in dengue fever and West Nile virus: A systematic review and meta-analysis. PLOS ONE [Internet]. 2018 Jul 10 [cited 2024 Oct 16];13(7):e0200200. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0200200

23. WHO. Obesity [Internet]. 2024. Available from: https://www.who.int/health-topics/obesity#tab=tab\_1

24. Hasan MN, Chowdhury MAB, Jahan J, Jahan S, Ahmed NU, Uddin MJ. Cesarean delivery and early childhood diseases in Bangladesh: An analysis of Demographic and Health Survey (BDHS) and Multiple Indicator Cluster Survey (MICS). PLOS ONE [Internet]. 2020 Dec 3 [cited 2024 Oct 7];15(12):e0242864. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0242864

25. Kim JH. Multicollinearity and misleading statistical results. Korean J Anesthesiol [Internet]. 2019 Dec [cited 2024 Oct 16];72(6):558–69. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6900425/

26. Wu F, Zhang Y, Cui W, Dong Y, Geng Y, Liu C, et al. Development and validation of a discrimination model between primary PLA2R-negative membranous nephropathy and minimal change disease confirmed by renal biopsy. Sci Rep. 2021 Sep 10;11(1):18064.

27. Hasan MN, Tambuly S, Trisha KF, Haque MdA, Chowdhury MAB, Uddin MJ. Knowledge of HIV/AIDS among married women in Bangladesh: analysis of three consecutive multiple indicator cluster surveys (MICS). AIDS Research and Therapy [Internet]. 2022 Dec 28 [cited 2024 Oct 16];19(1):68. Available from: https://doi.org/10.1186/s12981-022-00495-8

28. Huang N, Shen YJ, Chou YJ, Tsai TF, Lien CE. Advanced Age and Increased Risk for Severe Outcomes of Dengue Infection, Taiwan, 2014–2015. Emerg Infect Dis [Internet]. 2023 Aug [cited 2024 Oct 8];29(8):1701–2. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10370833/

29. Lin RJ, Lee TH, Leo YS. Dengue in the elderly: a review. Expert Review of Anti-infective Therapy [Internet]. 2017 Aug 3 [cited 2024 Oct 8];15(8):729–35. Available from: https://doi.org/10.1080/14787210.2017.1358610

30. Hossain MS, Noman AA, Mamun SAA, Mosabbir AA. Twenty-two years of dengue outbreaks in Bangladesh: epidemiology, clinical spectrum, serotypes, and future disease risks. Trop Med Health [Internet]. 2023 Jul 11 [cited 2024 Oct 8];51:37. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10334535/

31. Sami CA, Tasnim R, Hassan SS, Khan AH, Yasmin R, Monir-uz-Zaman M, et al. Clinical profile and early severity predictors of dengue fever: Current trends for the deadliest dengue infection in Bangladesh in 2022. IJID Regions [Internet]. 2023 Dec 1 [cited 2024 Oct 8];9:42–8. Available from: https://www.sciencedirect.com/science/article/pii/S2772707623000930

32. Sangkaew S, Ming D, Boonyasiri A, Honeyford K, Kalayanarooj S, Yacoub S, et al. Risk predictors of progression to severe disease during the febrile phase of dengue: a systematic review and meta-analysis. The Lancet Infectious Diseases [Internet]. 2021 Jul 1 [cited 2024 Oct 8];21(7):1014–26. Available from: https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30601-0/fulltext

33. Srisuphanunt M, Puttaruk P, Kooltheat N, Katzenmeier G, Wilairatana P. Prognostic Indicators for the Early Prediction of Severe Dengue Infection: A Retrospective Study in a University Hospital in Thailand. Trop Med Infect Dis [Internet]. 2022 Jul 31 [cited 2024 Oct 8];7(8):162. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9416179/

34. Latt KZ, Poovorawan K, Sriboonvorakul N, Pan-ngum W, Townamchai N, Muangnoicharoen S. Diabetes mellitus as a prognostic factor for dengue severity: Retrospective study from Hospital for Tropical Diseases, Bangkok. Clinical Infection in Practice [Internet]. 2020 Oct 1 [cited 2024 Oct 8];7–8:100028. Available from: https://www.sciencedirect.com/science/article/pii/S2590170220300157

35. Lee IK, Hsieh CJ, Lee CT, Liu JW. Diabetic patients suffering dengue are at risk for development of dengue shock syndrome/severe dengue: Emphasizing the impacts of co-existing comorbidity(ies) and glycemic control on dengue severity. Journal of Microbiology, Immunology and Infection [Internet]. 2020 Feb 1 [cited 2024 Oct 8];53(1):69–78. Available from: https://www.sciencedirect.com/science/article/pii/S1684118218300069

36. Ng WY, Atan R, Mohd Yunos N, bin Md Kamal AH, Roslan MH, Quah KY, et al. A double whammy: The association between comorbidities and severe dengue among adult patients—A matched case-control study. PLoS One [Internet]. 2022 Sep 20 [cited 2024 Oct 8];17(9):e0273071. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9488767/

37. dos Santos BF, Gandolfi FA, Milhim BHGA, Dourado FS, Silva GCD, Zini N, et al. Diabetes as risk factor to severity of dengue in naïve patients. medRxiv [Internet]. 2024 Apr 29 [cited 2024 Oct 8];2024.04.27.24306485. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC11092716/

38. Toledo J, George L, Martinez E, Lazaro A, Han WW, Coelho GE, et al. Relevance of Non-communicable Comorbidities for the Development of the Severe Forms of Dengue: A Systematic Literature Review. PLOS Neglected Tropical Diseases [Internet]. 2016 Jan 4 [cited 2024 Oct 8];10(1):e0004284. Available from: https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0004284

39. Akram A, Akram L, Ghosh UK, Abiduzzaman MF, Rahman S. Gastrointestinal Manifestations of Dengue Fever among Children: A Multicenter Cross-Sectional Study in Bangladesh. Bangladesh Journal of Medical Microbiology [Internet]. 2023 Dec 10 [cited 2024 Oct 8];17(2):66–70. Available from: https://www.banglajol.info/index.php/BJMM/article/view/69294

40. Al-Araimi H, Al-Jabri A, Mehmoud A, Al-Abri S. Dengue Haemorrhagic Fever presenting as Acute Abdomen. Sultan Qaboos Univ Med J [Internet]. 2011 May [cited 2024 Oct 8];11(2):265–8. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3121033/

41. Gupta BK, Nehara HR, Parmar S, Meena SL, Gajraj S, Gupta J. Acute abdomen presentation in dengue fever during recent outbreak. Journal of Acute Disease [Internet]. 2017 Sep [cited 2024 Oct 8];6(5):198. Available from: https://journals.lww.com/joad/fulltext/2017/06050/acute\_abdomen\_presentation\_in\_dengue\_fever\_during.2.aspx