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Emerging trends in dengue fever in Bangladesh: Demographic shifts, increased female prevalence and hepatic involvement

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Abstract

Background: Dengue fever remains a significant public health challenge in Bangladesh, with evolving epidemiological trends and clinical manifestations. Recent shifts in the demographic profile, including an increase in older adults and a notable rise in female cases, suggest changes in transmission dynamics and disease severity. This study aims to analyze these trends and provide insights into the changing nature of dengue fever in the country.

Objective: To investigate the demographic, clinical, laboratory, and serological features of dengue patients in Bangladesh, with a focus on identifying changes in disease patterns and severity in recent outbreaks.

Methods: A cross-sectional study was conducted on 440 dengue-confirmed patients across various healthcare centers in Bangladesh. Data were collected on patients' demographics, occupation, clinical presentation, laboratory results, and serological markers. Correlation analysis was performed to assess relationships between NS1 antigen levels and key biomarkers.

Results: The majority of patients were students (41.6%) and housewives (29.3%), with a significant shift toward older age groups, particularly those aged 46 and above (29.8%). Female patients represented 57.6% of the cohort, with a marked predominance in rural areas. Common symptoms included fever, gastrointestinal disturbances, and fatigue. Laboratory results revealed thrombocytopenia in 33.9% of cases, with elevated liver enzymes (ALT, AST) and CRP levels indicative of multi-organ involvement. Serological testing showed a high prevalence of secondary infections, with 76.3% IgG-positive cases and 50.9% IgM-positive cases. Strong correlations were found between NS1 antigen and liver enzymes (AST, ALT), and a moderate inverse correlation with platelet count.

Conclusion: Dengue fever in Bangladesh is increasingly impacting older adults and females, particularly in rural areas, with hepatic involvement rising and hemorrhagic symptoms declining. These trends call for updated diagnostic and

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management strategies, focusing on liver function and age-specific care. Further research is needed to explore the underlying factors.

Keywords: Dengue; Bangladesh; Clinical Trends; Serology; Hepatic Involvement

1. Introduction

Dengue fever has become an increasingly serious public health challenge in Bangladesh, with significant shifts in transmission patterns, clinical presentations, and the types of circulating virus strains[1]. Historically confined to urban areas like Dhaka, the disease has expanded rapidly into rural and peripheral regions[2]. The 2023 outbreak was the most severe recorded to date, with both infections and fatalities reaching unprecedented levels[3]. Notably, over half of the reported cases occurred outside the capital, signaling a concerning geographical spread.

Recent epidemiological data reveal a higher infection rate among males, with the most affected age group being between 19 and 29 years[4]. Despite this, the highest mortality rate remains among young children, particularly those aged 0 to 10 years. Common symptoms such as high fever, joint pain, and gastrointestinal disturbances have remained consistent[5]. However, new trends are emerging, including an increase in liver involvement and a reduction in bleeding-related complications. This suggests a shift in the disease's clinical course, which may be linked to changes in virus strains or evolving immune responses[6].

One of the major contributing factors behind the rise in severe cases during recent outbreaks is the dominance of Dengue Virus Serotype 2[7]. This strain, which has outpaced other serotypes in recent years, has been associated with more severe health outcomes, particularly involving hepatic damage[8]. A shift in serotype patterns is being observed globally, suggesting the virus's dynamic and evolving nature.

Environmental factors, especially rising temperatures and extended monsoon seasons, have significantly influenced the transmission of dengue fever in Bangladesh[9]. These climatic changes have created optimal breeding conditions for the *Aedes aegypti* mosquito, facilitating wider and more intense outbreaks[10]. As a result, the country's healthcare system, particularly in rural areas, has struggled to manage the increasing demand for diagnosis, treatment, and vector control measures[11]. The impact of these environmental factors calls for urgent public health interventions.

Given the evolving nature of dengue fever in Bangladesh, there is a pressing need to update existing health policies and management strategies[12]. This includes strengthening diagnostic capacities, revising treatment protocols, and improving vector control measures. Furthermore, increased research into the demographic and clinical shifts, particularly the rise in liver involvement and the changing patterns of infection among different age groups and genders, will be crucial for enhancing public health preparedness and response[13].

This study aims to provide a comprehensive analysis of the changing clinical and epidemiological nature of dengue fever in Bangladesh, highlighting key demographic trends, evolving clinical features, and the influence of environmental factors. It aims to offer critical insights that will inform better preparedness, diagnosis, treatment, and prevention strategies both locally and nationally.

2. Material and methods

2.1. Study Design and Setting

This hospital-based observational study was conducted at a diagnostic and imaging facility in Dhaka, Bangladesh. The research involved two integrated components. The first was a prospective clinical study conducted between July 2023 and May 2024. Simultaneously, an epidemiological surveillance study focused on dengue fever was carried out from February to October 2024. Both components used the same laboratory facility for diagnostic confirmation and imaging, ensuring consistency in testing procedures. Utilizing a centralized and well-equipped laboratory improved the reliability of results and aligned with recognized standards in infectious disease research within the country.

2.2. Study Population

A total of 440 patients presenting with febrile illness were included in the study. All patients met the clinical criteria for suspected dengue infection and were confirmed through standardized laboratory diagnostic tests. To ensure diagnostic accuracy, individuals with co-infections or those who were pregnant were excluded from the study. This exclusion criterion minimized confounding variables and enhanced the precision of the analysis.

2.3. Data Collection Procedures

Data were collected by trained medical researchers using structured case report forms. Demographic details such as age, gender, location of residence, and occupation were recorded. Clinical information included patients' medical history, vital signs, observed symptoms, disease progression, and treatment outcomes. This systematic data collection approach ensured consistency with other nationally conducted dengue surveillance studies. Special focus was placed on recognizing early warning signs, severity grading, and clinical outcomes based on the World Health Organization (WHO) dengue classification guidelines[14].

2.4. Laboratory Investigations

Laboratory tests were performed using automated analyzers for complete blood count assessments, including platelet and hematocrit levels. Dengue NS1 antigen and IgM antibodies were detected using rapid immunochromatographic tests for initial screening. In cases requiring additional assessment, liver function tests and viral hepatitis serology were also conducted. Imaging services such as abdominal ultrasound and contrast-enhanced CT scans were utilized for patients with suspected hepatic involvement. All imaging studies were reviewed by certified radiologists following standardized protocols[15].

2.5. Statistical Analysis

All collected data were compiled into a centralized electronic database to facilitate a unified analysis. Time-to-event outcomes were evaluated using Kaplan-Meier survival curves, while Cox proportional hazards models were applied to identify significant predictors of disease progression. Spatial-temporal modeling was used to analyze the distribution of dengue cases across regions and time. In addition, machine learning algorithms supported the prediction of severe clinical outcomes. To ensure data quality and validity, random sample cross-checking and routine calibration of diagnostic instruments were carried out during the study period.

2.6. Ethical Considerations

The study protocol received ethical approval from the appropriate institutional review board. Informed consent was obtained from all participants—written consent from literate individuals and witnessed verbal consent for those who were unable to read. All personal identifiers were removed prior to data analysis to maintain participant confidentiality. An independent monitoring committee supervised the study to ensure adherence to ethical standards in line with national public health research guidelines.

3. Results

The occupational profile of patients provides insight into the groups most vulnerable to dengue infection. Students accounted for the largest proportion of cases (41.6%), possibly due to high population density in educational institutions and dormitories, which are conducive to mosquito breeding. Housewives (29.3%) were the next most affected group, possibly due to prolonged exposure to domestic environments where Aedes mosquitoes are active during the day. Service holders, businessmen, and other outdoor professions also represented notable proportions, indicating widespread exposure across occupational settings.

Table 1 Occupational Distribution of Dengue Patients (n = 440)

Occupation	Percentage	Frequency
Students	41.6	183
Housewives	29.3	129
Service Holders	11.9	52
Businessmen	8.8	39
Farmers	2.1	9
Drivers	1.7	7
Others (Govt., Teachers, Unemployed)	4.6	20

The age-wise data reflects a significant demographic shift compared to past outbreaks. The most affected group was individuals aged 46 and above (29.8%), followed by the 36–45 age group (22%). This finding indicates a transition in vulnerability from younger individuals to middle-aged and older adults, possibly due to serotype shifts, accumulated immunity in younger populations, or occupational exposure. Pediatric infections (<15 years) accounted for only 8.5% of cases, showing a decline from historic rates (Table 2).

Table 2 Age Distribution of Dengue Cases

Age Group (Years)	Percentage	Frequency
<15	8.5	37
16–25	18.5	81
26–35	21.2	93
36–45	22.0	97
>46	29.8	131

There was a notable female predominance in this cohort (57.6%). This trend, consistent with recent years, deviates from traditional male-dominated patterns seen in earlier outbreaks. The disparity was more pronounced in rural areas (female-to-male ratio of 2.1:1), possibly reflecting differing domestic exposure or reporting patterns. Urban areas showed a more balanced distribution (1.2:1).

Table 3 Gender Distribution by Location

Gender	Overall %	Rural Ratio (F:M)	Urban Ratio (F:M)	Frequency
Female	57.6	2.1:1	1.2:1	254
Male	42.4	—	—	186

Fever was universal among all patients. Gastrointestinal symptoms such as nausea and vomiting were highly prevalent (59.5%), along with fatigue and eye redness. Musculoskeletal complaints and headache were also frequent. Less common but clinically significant signs included anemia, dehydration, and skin rash, potentially indicating progression toward severe dengue in some cases.

Table 4 Clinical Features of Dengue Patients

Symptom	Prevalence (%)	Frequency
Fever	100.0	440
Nausea and Vomiting	59.5	262
Fatigue	42.5	187
Redness of Eyes	41.2	181
Muscle/Joint Pain	36.1	159
Headache	25.3	111
Retro-orbital Pain	19.3	85
Abdominal Pain	18.2	80
Skin Rash	14.1	62
Anemia	7.2	32
Dehydration	6.8	30

The average platelet count remained below normal (mean: 97,826/mm^3), though thrombocytopenia was present in only 33.9%—a marked decline from previous outbreaks. Leukopenia was found in one-fourth of patients, and 18% showed a biphasic leukocyte pattern, often indicative of recovery. Elevated liver enzymes (ALT, AST) and hyperbilirubinemia point to hepatic involvement. High CRP and creatinine levels in some patients suggest systemic inflammation and renal strain.

Table 5 Hematological and Biochemical Parameters

Parameter	Value / Prevalence	Frequency
Mean Platelet Count	97,826 ± 17,152 /mm^3	—
Thrombocytopenia (<150,000/mm^3)	33.9%	149
Leukopenia (<4,000/mm^3)	25.4%	112
Biphasic Leukocyte Reaction	18.0%	79
Hemoconcentration (HCT >47%)	13.6%	60
Elevated CRP (>10 mg/L)	21.1%	93
ALT	95.6 ± 86.5 U/L	—
AST	81.1 ± 55.7 U/L	—
Hyperbilirubinemia (>2 mg/dL)	12.4%	55
Elevated Creatinine (>1.2 mg/dL)	9.3%	41

Serological testing revealed that 76.3% of patients were IgG positive, indicating secondary dengue infections—a trend associated with higher risk of complications. Half the cohort was IgM positive, suggesting a mix of primary and recent infections during the testing window.

Table 6 Serological Test Results

Serological Marker	Result (%)	Frequency
IgG Positive	76.3	335
IgG Negative	23.7	105
IgM Positive	50.9	224
IgM Negative	49.1	216

Correlation analysis between NS1 antigen and key biomarkers provided insight into disease severity indicators. Strong positive correlations were found between NS1 levels and liver enzymes (AST: r = 0.72; ALT: r = 0.65), suggesting hepatocellular damage due to viral toxicity. A moderate negative correlation with platelet count (r = -0.58) reinforces NS1's role in coagulopathy. The CRP correlation was weak and nonsignificant, indicating inflammation may proceed through NS1-independent mechanisms. Bilirubin and hemoglobin levels were modestly correlated, potentially reflecting hemolytic changes in subsets of patients.

Table 7 Correlation Between NS1 Antigen and Key Biomarkers

Correlation Pair	r-value	p-value
NS1 vs AST	0.72	<0.001
NS1 vs ALT	0.65	<0.001
NS1 vs Platelet Count	-0.58	0.003
Bilirubin vsHemoglobin	0.41	0.020
NS1 vs CRP	0.08	0.450

4. Discussion

The findings of this study illustrate a significant shift in the clinical and epidemiological landscape of dengue fever in Bangladesh, suggesting that the disease is evolving in terms of both its demographic impact and clinical presentation. These changes, particularly the shift toward older age groups and the increasing predominance of females, raise new concerns for public health management and warrant closer examination of the factors contributing to these trends.

The study reveals a noteworthy demographic transition, with individuals aged 46 and above now accounting for nearly 30% of the cases, a marked increase compared to previous outbreaks where younger populations (e.g., <15 years) were more predominantly affected. This shift may be attributed to various factors such as serotype changes, age-specific immunity, and environmental exposures. While pediatric cases represented only 8.5% of the total, the prevalence of dengue among older individuals could suggest that herd immunity in younger populations—driven by previous exposure to dengue virus or vaccination efforts—might be playing a role in lowering the incidence of infections among children.In terms of occupational exposure, students and housewives comprised the largest groups of dengue patients, which aligns with previous findings that highlight the risks posed by densely populated environments such as schools and urban homes, where the Aedes mosquitoes are prevalent[16]. The increase in cases among service holders and businessmen also emphasizes the widespread nature of exposure in both indoor and outdoor environments, thus confirming that dengue is no longer confined to rural or peri-urban areas but has become a more generalized health concern[17].

One of the most striking findings of this study was the female predominance among dengue patients, especially in rural areas (female-to-male ratio of 2.1:1). This represents a significant departure from the traditionally male-dominated trend seen in earlier dengue outbreaks in Bangladesh, where males often exhibited higher rates of infection. Several possible explanations for this shift include sociocultural factors, such as differences in exposure based on domestic roles, and potentially biological factors that may influence immune responses. Similar trends have been reported in other regions, including Latin America, where outbreaks also saw a rise in female cases, particularly in rural settings[18]. Further studies focusing on environmental exposures, domestic roles, and mosquito control interventions in rural areas are needed to explore these gender disparities in more detail.

The clinical features of dengue in this study align with those reported in other recent outbreaks, with fever being universally present and gastrointestinal symptoms such as nausea, vomiting, and fatigue being highly prevalent. However, it is the observed decline in the severity of bleeding manifestations (only 8.0%) and the emergence of liver involvement (38.2%) that stand out as significant changes in clinical presentation. The hepatotoxic effects noted in this cohort, particularly the strong correlation between elevated liver enzymes (ALT, AST) and NS1 antigen levels, are consistent with findings from other studies that have reported increased liver involvement in recent dengue outbreaks, particularly with DENV-2 infections, which are known to have more severe hepatic effects[19].The reduction in bleeding severity contrasts with earlier observations that highlighted hemorrhagic signs as a hallmark of severe dengue. This change may indicate a shift in the clinical course of the disease, possibly due to changes in viral strain characteristics or a greater emphasis on early intervention and improved management of severe cases in clinical settings. Further investigation into the role of platelet function, rather than just platelet count, could provide more insight into these clinical shifts.

Laboratory analysis further corroborates the clinical findings, with thrombocytopenia (33.9%) and leukopenia (25.4%) remaining prevalent but at lower rates compared to previous outbreaks. This decrease in the incidence of severe thrombocytopenia (<20,000/mm^3), combined with the elevated liver enzymes and CRP levels, points to multi-organ involvement and an inflammatory response that may be contributing to disease severity. Interestingly, the correlation between NS1 antigen levels and hepatic markers (AST, ALT) highlights a direct association between viral replication and liver damage. The negative correlation between NS1 and platelet count also underscores the role of NS1 antigen in modulating coagulopathy and platelet dysfunction, a known feature of severe dengue[20].

Comparing these findings with those from previous studies, it is evident that while platelet count remains a useful indicator, more comprehensive markers—such as hepatic function tests—are becoming essential for assessing dengue severity[21]. This supports the emerging concept that liver involvement, rather than just thrombocytopenia, may be a key determinant of clinical outcome in modern dengue cases. The serological findings of this study reveal that 76.3% of the cohort was IgG positive, indicating that secondary infections were prevalent, which is often associated with an increased risk of severe dengue[22]. This is consistent with global patterns, where secondary infections with different dengue virus serotypes contribute to more severe disease and complications. Additionally, the significant presence of IgM positivity (50.9%) suggests that both primary and recent infections were occurring simultaneously during the study period[23]. The increased rate of IgG positivity raises important questions regarding the accuracy of diagnostic tools and the potential

for cross-reactivity with other flaviviruses, such as Zika and Chikungunya[24]. This cross-reactivity could complicate diagnosis and has important implications for vaccine development and immunization strategies, as it could affect the immune response and clinical presentation in individuals with pre-existing flavivirus immunity.

Finally, the environmental conditions that influence *Aedes mosquito* breeding patterns—such as temperature and rainfall—are critical in shaping the epidemiology of dengue in Bangladesh[25]. As climate change continues to alter these factors, dengue transmission could become even more unpredictable, underscoring the need for proactive vector control measures and surveillance systems. Studies have demonstrated that higher temperatures and increased rainfall contribute to higher mosquito populations and extended breeding seasons, thus highlighting the importance of integrating climate-adaptive strategies into dengue prevention programs[26].

5. Conclusion

This study underscores the evolving nature of dengue fever in Bangladesh, with significant demographic, clinical, and serological shifts observed in recent outbreaks. The rising incidence of dengue among older populations, the increased female-to-male ratio, and the emergence of liver involvement as a key clinical feature all point to changes in the transmission dynamics and pathophysiology of the disease. These findings highlight the urgent need for updated clinical guidelines, improved diagnostic tools, and enhanced public health interventions tailored to the changing profile of dengue. Further research into age-specific immunity, gender disparities, and vector control in urban and rural settings is critical to mitigate the impact of future outbreaks and to refine prevention strategies for the most at-risk populations

Compliance with ethical standards

Disclosure of conflict of interest

There is no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Author contributions

M.S.B., H.I and M.S.R conceptualized, conducted lab and field works, analyzed data, wrote the original draft, reviewed, and edited; S.S.D and F.R. conducted research design, validated methodology, analyzed, visualized the data, reviewed, and edited; N.F.S and T.A. validated the methodology, analyzed data, investigated, visualized, reviewed, and proof-read; N.D., F.A.R., and R.C. conceptualization, conducted research design, validated methodology, conducted analysis, investigated, visualized the data, reviewed, supervised and edited the paper. All authors read and approved the paper for publication.

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