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Association Between Hematocrit And Platelet Count In Dengue Hemorrhagic Fever: A 2022 Outbreak Study In Dhaka

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Abstract

Background: *Dengue Hemorrhagic Fever (DHF) is a severe form of dengue fever, a mosquito-borne disease that is a significant public health concern in tropical and subtropical regions. This study aimed to investigate the association between hematocrit levels and platelet counts in patients with DHF during a 2022 outbreak in Dhaka.*

Methods: *This prospective observational study was conducted at Kurmitola general hospital, a dengue dedicated hospital in Dhaka, Bangladesh from January to December' 2022with a total of 239 patients diagnosed with DHF. Data were collected on sociodemographic characteristics, clinical presentations, comorbidities, and dengue diagnosis tests. Hematocrit levels and platelet counts were categorized, and their associations with dengue diagnosis tests were analyzed.*

Result: *The majority of the participants were males (74.14%) and urban residents (87.07%). The most common clinical presentation was high fever (>102° F), observed in 99.57% of the participants. The majority of the participants were diagnosed as NS1 positive (90.95%). No significant association was found between platelet values (dengue type) and hematocrit value categorization (p=0.89). However, a significant association was observed between dengue diagnosis tests and hematocrit categorization (p=0.001 for NS1 positive test and p<0.001 for IgM positive test).*

Conclusion: *This study provides valuable insights into the clinical presentation and diagnostic parameters of Dengue Hemorrhagic Fever in an outbreak context. The findings highlight the importance of comprehensive diagnostic testing, including NS1 antigen detection and IgM antibody testing, in the early identification and management of dengue. Further research is warranted to explore the complex relationships between hematocrit levels, platelet counts, and dengue severity, which could inform targeted interventions to improve patient outcomes.*

Keywords: *Dengue, Fever, Hematocrit, Platelet*

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I. INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is a severe manifestation of the mosquito-borne viral disease, dengue fever, which is rapidly spreading across the globe.[1] The disease is transmitted by the Aedes aegypti and Aedes albopictus mosquitoes and presents a significant public health challenge in tropical and subtropical regions, including Bangladesh.[2]In 2022, alongside the global Covid-19 pandemic, Bangladesh experienced a significant outbreak of DHF, particularly in its capital city, Dhaka.[3] This study focuses on this outbreak, investigating the correlation between platelet count and hematocrit levels in patients diagnosed with DHF.Platelets, or thrombocytes, play a crucial role in blood clotting, and their count can significantly decrease in patients with DHF, leading to severe bleeding and shock.[4] Hematocrit, the volume percentage of red blood cells in blood, can also fluctuate in DHF cases, often increasing due to plasma leakage, a hallmark of severe dengue.[5]Previous studies have suggested that platelet indices may have diagnostic and prognostic value in DHF.[6] However, the clinical applications of these parameters have not been substantially implemented, and further research is needed to understand their potential role in the prognosis and management of DHF.[4] This present study aims to contribute to this body of knowledge by analyzing the correlation of platelet count and hematocrit with DHF during the 2022 outbreak in Dhaka, Bangladesh.Dengue fever and its severe form, DHF, are major public health problems in Southeast Asia, including Bangladesh.[7] The World Health Organization (WHO) estimates that about half of the world's population is at risk of dengue, with a significant proportion of cases occurring in Southeast Asia.[8]The clinical presentations of dengue fever vary widely, but common symptoms include fever, myalgia, nausea, vomiting, and abdominal pain. In severe cases, dengue can progress to DHF, characterized by plasma leakage, fluid accumulation, respiratory distress, severe bleeding, and organ impairment.[5]The risk factors for dengue and DHF include environmental factors such as high population density, poor sanitation, and the presence of Aedes mosquitoes. Individual factors such as age, gender, and immune status also play a role.[1]DHF has a significant impact on daily life, causing substantial morbidity and mortality. It also places a heavy burden on healthcare systems, particularly during outbreaks.[8] In Bangladesh, the dengue outbreak in recent years has led to a surge in hospital admissions, straining healthcare resources.[9,10]The objective of the present study is to explore the relationship between hematocrit levels and platelet count in patients diagnosed with DHF. By examining these parameters, we hope to provide a deeper understanding of their role in the pathophysiology of DHF. This research could potentially contribute to the development of more effective diagnostic and prognostic tools for DHF, ultimately improving patient outcomes and healthcare resource allocation during dengue outbreaks. The findings of this study could also provide valuable insights for healthcare professionals and policymakers in Bangladesh and other regions affected by dengue, aiding in the development of strategies to manage and control future outbreaks of the disease.

II. METHODS

This observational, cross-sectional study was conducted at the Department of Medicine, Kurmitola general hospital, Dhaka, a dengue dedicated Hospital in Bangladesh at that time from January 2022 to December 2022, comprising of 239 patients who presented with signs and symptoms of dengue fever and were admitted to the hospital. The inclusion criteria were all adult patients of 18 or more years of age and genders who were diagnosed with dengue and Dengue hemorrhagic fever based on clinical symptoms and confirmed by laboratory tests, including the NS1 antigen test, IgM and IgG antibody tests for dengue virus.The exclusion criteria were patients with other hematological disorders or conditions that could affect platelet count or hematocrit levels, and those who did not consent to participate in the study. Data were collected from the patient or relatives with their consent after getting an approval from the institutional review board, applying an easily understandable data collection questionnaire. Data included demographic information, clinical symptoms, and laboratory results. The primary variables of interest were platelet count and hematocrit levels, which were measured at the time of admission and monitored throughout the patients' hospital stay. The correlation between these two variables in patients with dengue and DHF was analyzed using appropriate statistical methods. Ethical approval for the study was obtained from the hospital's ethics committee, and all data were anonymized to maintain patient confidentiality. The findings from this study will contribute to the understanding association and severity of DHF with hematocrit and platelet values, and potentially aid in the development of more effective diagnostic, management and prognostic tools for these diseases.

III. RESULTS

Table 1: Distribution of participants by sociodemographic characteristics (N=239)

Variable	Frequency	Percentage

Age Groups		
<20	42	18.10%
20-29	86	37.07%
30-39	53	22.84%
40-49	24	10.34%
50-59	15	6.47%
60-69	11	4.74%
70-79	2	0.86%
≥80	6	
Gender		
Male	172	74.14%
Female	67	28.88%
Residence		
Urban	202	87.07%
Semi-urban	37	15.95%

Table 1 delineated the sociodemographic distribution of the 239 participants involved in the study. Participants were categorized into various age groups, with the majority falling within the 20-29 age bracket, representing 37.07% (n=86) of the total sample. The next substantial age group was those aged 30-39, comprising 22.84% (n=53) of the participants. The least represented age groups were those aged 70-79 and 80 or above, accounting for 0.86% (n=2) and 2.51% (n=6) of the sample, respectively.Gender distribution revealed a male predominance, with males constituting 74.14% (n=172) of the total participants, while females accounted for the remaining 28.88% (n=67). This suggested a higher incidence of dengue among males in the study population.Residential data indicated that the majority of the participants, 87.07% (n=202), resided in urban areas, while 15.95% (n=37) were from semi-urban areas.

Table 2: Distribution of participants by clinical presentations (N=239)

Clinical Presentations	**Frequency**	**Percentage**
High Fever (>102° F)	231	99.57%
Body ache	104	44.83%
Gastroenteritis	97	41.81%
Abdominal Pain	58	25.00%
Bleeding	34	14.66%
Evidence of Plasma Leakage	28	12.07%
Cough	11	4.74%
Fever (≤102° F)	8	3.45%

Table 2 illustrates the distribution of the 239 participants based on their clinical presentations. The most common clinical presentation was high fever (greater than 102° F), which was observed in 99.57% (n=231) of the participants. This was followed by body ache and gastroenteritis, reported by 44.83% (n=104) and 41.81% (n=97) of the participants, respectively.Abdominal pain was another notable symptom, experienced by a quarter of the participants, representing 25.00% (n=58) of the total sample. Bleeding, a severe symptom often associated with Dengue Hemorrhagic Fever, was reported by 14.66% (n=34) of the participants.Evidence of plasma leakage, another hallmark of severe dengue, was found in 12.07% (n=28) of the participants. Less common clinical presentations included cough and fever less than or equal to 102° F, reported by 4.74% (n=11) and 3.45% (n=8) of the participants, respectively.

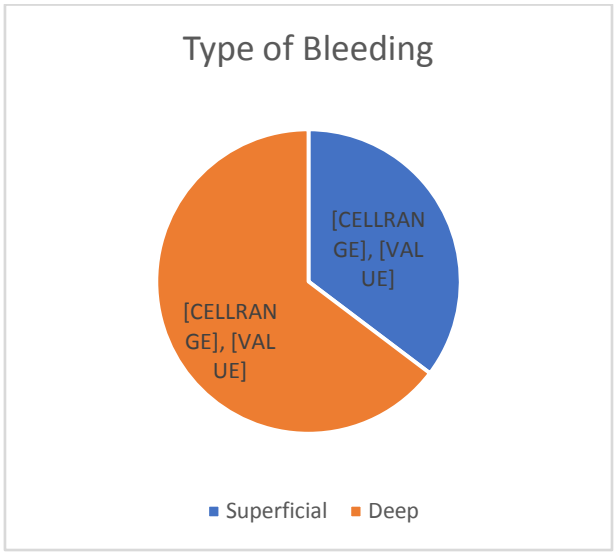

Figure 1: Distribution of participants by type of bleeding (n=34)

Figure 2 presents the distribution of the 34 participants who reported bleeding, categorized by the type of bleeding. The majority of these participants, 64.71% (n=22), experienced deep bleeding. The remaining 35.29% (n=12) reported superficial bleeding.

Table 3: Distribution of Dengue Diagnosis Types (positive) Among Patients (N=239)

Dengue Diagnosis	Frequency	Percentage
NS1 Positive	211	90.95%
IgM Positive	18	7.76%
IgG Positive	33	14.22%

Table 4 provides the distribution of the 239 participants based on the type of positive dengue diagnosis. The majority of the participants, 90.95% (n=211), were diagnosed as NS1 positive. This antigen is typically detectable in the blood within the first few days of infection, making it a valuable early marker for dengue. IgM antibodies, which typically appear within a few days after the onset of illness and persist for several weeks, were detected in 7.76% (n=18) of the participants. IgG antibodies, which appear later and persist, indicating past infection or secondary dengue infection, were found in 14.22% (n=33) of the participants.

Table 4: Distribution of participants by hematocrit value categorization (n=239)

Hematocrit values	Frequency	Percentage
Severely Low HCT	15	6.47%
Mildly low HCT	80	34.48%
Normal	135	58.19%
Mildly High	8	3.45%
Severely High	1	0.43%

Table 5 presents the distribution of the 239 participants based on the categorization of hematocrit values. The majority of the participants, 58.19% (n=135), had normal hematocrit values. Mildly low hematocrit values were observed in 34.48% (n=80) of the participants, while severely low hematocrit values were reported in 6.47% (n=15) of the participants. On the higher end of the spectrum, mildly high hematocrit values were found in 3.45% (n=8) of the participants, and severely high hematocrit values were observed in 0.43% (n=1) of the participants.

Table 5: Distribution of participants by dengue categorization using platelet values at admission (n=239)

Dengue Category	**Frequency**	**Percentage**
Normal (>1,50,000)	42	18.10%
Mild Dengue (1,00,001-1,50,000)	32	13.79%
Moderate Dengue (50,001-1,00,000)	46	19.83%
Severe Dengue (20,001-50,000)	64	27.59%
Dengue Hemorrhagic Fever (<20,000)	55	23.71%

Table 6 illustrates the distribution of the 239 participants based on the categorization of dengue severity using platelet values at admission. The majority of the participants, 27.59% (n=64), were categorized as having severe dengue, with platelet counts ranging from 20,001 to 50,000. This was closely followed by those categorized as having Dengue Hemorrhagic Fever, with platelet counts less than 20,000, representing 23.71% (n=55) of the participants. Moderate dengue, defined by platelet counts between 50,001 and 1,00,000, was observed in 19.83% (n=46) of the participants. Mild dengue, with platelet counts ranging from 1,00,001 to 1,50,000, was reported in 13.79% (n=32) of the participants. Normal platelet counts, greater than 1,50,000, were observed in 18.10% (n=42) of the participants.

Table 6: Association between Hematocrit categorization and dengue type

HCT Category		Dengue Category					p-value
		Normal	Mild Dengue	Moderate Dengue	Severe Dengue	Dengue Hemorrhagic Fever	
Severely Low HCT	Frequency	3	3	2	2	5	0.89
	% within Dengue Category	7.1%	9.4%	4.3%	3.1%	9.1%	
Mildly low HCT	Frequency	12	12	15	23	18	
	% within Dengue Category	28.6%	37.5%	32.6%	35.9%	32.7%	
Normal	Frequency	26	17	26	37	29	
	% within Dengue Category	61.9%	53.1%	56.5%	57.8%	52.7%	
Mildly High	Frequency	1	0	3	2	2	
	% within Dengue Category	2.4%	0.0%	6.5%	3.1%	3.6%	
Severely High	Frequency	0	0	0	0	1	
	% within Dengue Category	0.0%	0.0%	0.0%	0.0%	1.8%	

Table 7 presents the association between hematocrit (HCT) categorization and dengue type. The p-value of 0.89 suggests that there is no statistically significant association between these two variables. Looking at the distribution within each dengue category, for those with normal HCT values, the majority fell into all dengue categories, ranging from 52.7% in Dengue Hemorrhagic Fever to 61.9% in the Normal category. This was followed by those with mildly low HCT values, with the highest representation in the Severe Dengue category at 35.9% and the lowest in the Normal category at 28.6%. Participants with severely low HCT values were relatively evenly distributed across the dengue categories, with the highest percentage in Dengue Hemorrhagic Fever at 9.1% and the lowest in Severe Dengue at 3.1%. Those with mildly high HCT values were mostly found in the Moderate Dengue category at 6.5%, and were not present in the Mild Dengue category. Lastly, participants with severely high HCT values were only found in the Dengue Hemorrhagic Fever category, representing 1.8% of that category.

Table 7: Association between hematocrit categorization and dengue diagnosis test

Dengue diagnosis test		HCT Category					P-value
		Severely Low HCT	Mildly low HCT	Normal	Mildly High	Severely High	
NS1 Positive	Frequency	15	68	124	3	1	**0.001**
	% within HCT Category	100.00%	87.20%	91.90%	42.90%	100.00%	
IgM Positive	Frequency	0	5	9	4	0	**<0.001**
	% within HCT Category	0.00%	6.40%	6.80%	50.00%	0.00%	
IgG Positive	Frequency	0	12	19	2	0	0.473
	% within HCT Category	0.00%	15.40%	14.30%	25.00%	0.00%	

Table 8 presents the association between hematocrit (HCT) categorization and dengue diagnosis tests. For the NS1 positive test, there was a significant association with HCT categorization (p=0.001). All participants with severely low HCT and severely high HCT were NS1 positive. The majority of participants with normal and mildly low HCT were also NS1 positive, at 91.9% and 87.2% respectively. However, only 42.9% of participants with mildly high HCT were NS1 positive. For the IgM positive test, there was a highly significant association with HCT categorization (p<0.001). Half of the participants with mildly high HCT were IgM positive, while none of the participants with severely low HCT or severely high HCT were IgM positive. The percentage of IgM positive participants was similar for those with normal and mildly low HCT, at 6.8% and 6.4% respectively. For the IgG positive test, there was no significant association with HCT categorization (p=0.473). A quarter of participants with mildly high HCT were IgG positive, while none of the participants with severely low HCT or severely high HCT were IgG positive. The percentage of IgG positive participants was similar for those with normal and mildly low HCT, at 14.3% and 15.4% respectively.

Table 8: Bivariate correlation showing associations between various factors among participants (N=239)

Correlations		Age	Gender	Fever Duration	HCT Category	Dengue Category	NS1	IgM	IgG
Age	Pearson Correlation	1	0.033	-.141*	-.251**	-0.015	-0.054	-0.076	-0.071
	Sig. (2-tailed)		0.612	**0.031**	**<0.001**	0.821	0.413	0.246	0.279
Gender	Pearson Correlation	0.033	1	-0.031	-.247**	-0.115	-0.092	.180**	.171**
	Sig. (2-tailed)	0.612		0.632	0	0.077	0.16	**0.006**	**0.009**
Fever Duration	Pearson Correlation	-.141*	-0.031	1	-0.026	-0.052	0.077	-0.027	-0.06
	Sig. (2-tailed)	**0.031**	0.632		0.694	0.424	0.242	0.679	0.361
HCT Category	Pearson Correlation	-.251**	-.247**	-0.026	1	0.014	0.092	-.153*	-0.068
	Sig. (2-tailed)	**<0.001**	**<0.001**	0.694		0.825	0.161	0.019	0.302
Dengue Category	Pearson Correlation	-0.015	-0.115	-0.052	0.014	1	-0.009	-0.041	0.078
	Sig. (2-tailed)	0.821	0.077	0.424	0.825		0.889	0.528	0.231
NS1	Pearson Correlation	-0.054	-0.092	0.077	0.092	-0.009	1	-.330**	-.416**
	Sig. (2-tailed)	0.413	0.16	0.242	0.161	0.889		**<0.001**	**<0.001**
IgM	Pearson Correlation	-0.076	.180**	-0.027	-.153*	-0.041	-.330**	1	.344**
	Sig. (2-tailed)	0.246	**0.006**	0.679	**0.019**	0.528	**<0.001**		**<0.001**
IgG	Pearson Correlation	-0.071	.171**	-0.06	-0.068	0.078	-.416**	.344**	1
	Sig. (2-tailed)	0.279	**0.009**	0.361	0.302	0.231	**<0.001**	**<0.001**	

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 9 provides a bivariate correlation matrix showing associations between various factors among the 239 participants. Age was found to have a significant negative correlation with fever duration (r=-.141, p=0.031) and HCT category (r=-.251, p<0.01), indicating that as age increases, fever duration and HCT category tend to decrease. Gender was significantly negatively correlated with HCT category (r=-.247, p<0.01) and positively correlated with IgM (r=.180, p<0.01) and IgG (r=.171, p<0.01), suggesting that gender is associated with these factors. HCT category was significantly negatively correlated with IgM (r=-.153, p=0.019), indicating that as HCT category increases, IgM tends to decrease. NS1 was significantly negatively correlated with IgM (r=-.330, p<0.01) and IgG (r=-.416, p<0.01), suggesting that as NS1 increases, IgM and IgG tend to decrease. IgM and IgG were significantly positively correlated (r=.344, p<0.01), indicating that as IgM increases, IgG also tends to increase.

IV. DISCUSSION

The sociodemographic distribution of the participants in our study revealed a higher incidence of dengue among males (74.14%, n=172) and those residing in urban areas (87.07%, n=202). This is in line with the findings of Gubler (1998), who reported that urbanization and the associated increase in the density of Aedes aegypti mosquitoes contribute to the high incidence of dengue in urban areas.[11] The higher incidence among males in our study could be attributed to increased exposure to mosquito bites due to occupational or behavioral factors, a finding that warrants further investigation.The clinical presentation of our participants was predominantly high fever (greater than 102° F), reported in 99.57% (n=231) of the cases. This is consistent with the findings of Kamath et al. (2006), who reported high fever as a common symptom in severe forms of dengue.[12] The presence of other symptoms such as body ache, gastroenteritis, and abdominal pain in our study population further corroborates the clinical complexity of dengue, as noted by Simmons et al. (2012).[13]Our study found that the majority of the participants were diagnosed as NS1 positive (90.95%, n=211), an early marker for dengue. This is in line with the WHO (2009) guidelines, which recommend NS1 antigen detection for early dengue diagnosis.[14] The detection of IgM and IgG antibodies in 7.76% (n=18) and 14.22% (n=33) of our participants, respectively, indicates past infection or secondary dengue infection, highlighting the importance of serological testing in dengue diagnosis.The hematocrit values in our study population were predominantly normal (58.19%, n=135), with a significant proportion having mildly low values (34.48%, n=80). This is in contrast to the findings of Guzman et al. (2010), who reported elevated hematocrit levels as a common feature in dengue patients.[1] The discrepancy could be due to differences in the timing of sample collection or the severity of dengue among the study populations.Our study found no significant association between platelet values (dengue type) and hematocrit value categorization (p=0.89). This contrasts with the common perception that thrombocytopenia and hemoconcentration are hallmark features of dengue, as noted by Gubler (1998).[11] This discrepancy could be due to the heterogeneity in the clinical presentation of dengue or the timing of sample collection, underscoring the need for further studies to elucidate the relationship between these parameters.Interestingly, our study found a significant association between dengue diagnosis tests and HCT categorization (p=0.001 for NS1 and p<0.001 for IgM). This suggests that the type of dengue diagnostic test and the hematocrit level may influence each other, a finding that warrants further investigation to understand its implications for dengue diagnosis and management.In the bivariate correlation analysis, age was found to have a significant negative correlation with fever duration (r=-.141, p=0.031) and HCT category (r=-.251, p<0.01). This suggests that older individuals may have shorter fever durations and lower HCT categories, a finding that is in line with the study by Simmons et al. (2012), who reported that age can influence the clinical presentation and outcomes of dengue.[13]In conclusion, our study provides valuable insights into the sociodemographic and clinical characteristics of dengue patients in Dhaka during the 2022 outbreak. The findings underscore the importance of early diagnosis, comprehensive clinical assessment, and appropriate management strategies in improving the outcomes of dengue patients. Further studies are needed to validate our findings and explore the factors influencing the clinical presentation and outcomes of dengue in this population.

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

V. CONCLUSION

The study revealed a higher prevalence of dengue among males and urban residents, highlighting the need for targeted public health interventions in these populations. The lack of a significant association between platelet values and hematocrit categorization suggests that these parameters may independently contribute to the clinical presentation and severity of dengue. However, the significant association observed between dengue

diagnosis tests and hematocrit categorization underscores the importance of these tests in the early detection and management of dengue. The correlations observed in the bivariate correlation table further emphasize the complex interplay of various factors in dengue patients. These findings can guide future research and contribute to the development of more effective strategies for the prevention, diagnosis, and treatment of dengue. In conclusion, this study contributes to the understanding of dengue's clinical and demographic characteristics and the associations between key clinical parameters. The findings underscore the importance of comprehensive diagnostic testing and targeted public health interventions in managing dengue, particularly in high-risk populations. Further research is needed to elucidate the complex interplay of factors influencing dengue's clinical presentation and severity, ultimately contributing to improved patient outcomes.

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