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The Pattern of Hematological and Biochemical Parameters in Dengue Fever among Patients Presenting to HIT Hospital, Taxila Cantt

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ABSTRACT

Dengue fever affects over 600 million people globally each year, with its burden increasing eightfold in the past 15 years. It is endemic in 129 nations. **Objective:** To identify the pattern of hematological and biochemical parameters in patients at HIT Hospital, Taxila, and examine their correlation. **Methods:** This retrospective cross-sectional study analyzed data from 118 patients with positive serology reported between August and November 2022. Parameters studied included hemoglobin, hematocrit, platelets, leucocyte count, and plasma Alanine transaminase (ALT) levels. **Results:** Among 118 patients, 77 were male, and 41 were female. Patients under 18 years comprised 8.5%, those aged 18–49 years constituted 61.0%, and those aged 50+ accounted for 30.5%. Severe dengue cases showed significantly reduced platelet counts across all age groups ($p < 0.05$). In mild dengue, 3 of 17 patients had normal ALT levels, while 11 showed abnormal levels. In moderate cases, 27 of 87 had normal ALT levels, while 60 exhibited elevated levels. Severe cases showed elevated ALT levels in 16 of 17 patients. **Conclusions:** Males and individuals aged 18–49 are more vulnerable to dengue and should take extra precautions. Elevated liver transaminases, leucopenia, and thrombocytopenia indicate a high likelihood of dengue infection, aiding diagnosis and treatment planning. Awareness campaigns must be expanded to larger populations, including literate individuals, to prevent the disease effectively.

INTRODUCTION

Dengue fever affected over 6.5 million people worldwide in 2023, and as of 30th April 2024 WHO has reported 3.4 million confirmed cases making it a serious health risk [1, 2]. It is a virus-borne illness that is transmitted by female *Aedes agypti* mosquito bites [3]. Over the past 15 years, the burden of sickness has increased eightfold. Dengue is endemic in around 129 countries of the world, i.e., Africa, America, Southeast Asia, and the Mediterranean region. Around 70% of the disease burden is present in Asia [4]. In Pakistan, major outbreaks of dengue fever were reported in Lahore (Punjab) and Swat (KPK) in 2011 and 2013 respectively with a 20% mortality rate. The total number of cases reported during 2000-2019 was 201,269. The majority of dengue-infected cases were reported as Dengue fever (74.4%) followed by DHF (dengue hemorrhagic fever) (24.1%) and DSS (dengue shock syndrome) (1.5%). Overall the deaths during the survey were 1082, of which the maximum mortalities were reported from KPK (N=248) followed by Punjab (N=220) [5]. In year 2019 cases reported were with 75 deaths, while in 2022 79,009 confirmed cases of dengue were reported with 149 deaths [1]. There are four serotypes of the encapsulated RNA virus known as dengue: DEN1,

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DEN2, DEN3, and DEN4. Travelers contribute significantly to the spread of this virus. The World Health Organization (WHO) classifies the disease into two categories: dengue with or without warning signs, and severe dengue. Primary infection with any serotype provides immunity against the respective serotype, whereas secondary infection with the heterologous serotype leads to severe dengue [6]. The clinical manifestations of dengue infection typically include sudden onset of high fever, severe headache, retro-orbital pain, myalgia, arthralgia, and rash. While most of the cases of dengue fever resolve with supportive care, dengue hemorrhagic fever and dengue shock syndrome can lead to vascular leakage, hemorrhage, and shock, necessitating prompt medical intervention [7]. According to literature, there is an important role of hematological factors such as thrombocytopenia, raised hematocrit, leukocytosis, and decreased hemoglobin levels in the diagnosis and prognosis of dengue fever [8]. Many studies have revealed the involvement of the liver in this disease. The serum transaminases are raised during a viral illness. This is +due to multiple causes, including viral load, apoptosis, and immunological factors [9]. Urbanization, high humidity, inadequate sanitation, and a lack of vector control measures are the main causes of dengue's quick spread [10]. Supportive care, fluid replacement, and monitoring for complications like shock-causing plasma leakage are all part of managing a dengue infection. In extreme situations, prompt intravenous fluid and blood product administration may be required to stabilize the patient and avoid death [11]. Additionally, in order to stop dengue disease from spreading, vector control techniques are crucial. This entails removing Aedes mosquito breeding grounds and launching community-wide pesticide spraying initiatives [12, 13]. Taxila is an urbanized tehsil of around 6 million populations densely populated with humid temperature conditions favoring the dengue spread and its recurrent episodes. A large number of people have suffered from dengue infection and are susceptible to recurrent episodes. It is very important to study different patterns of Dengue fever among patients because few studies have been done on dengue in Taxila.

Dengue fever continues to impose a severe and escalating public health burden in Pakistan, with over 79,000 confirmed cases and 149 deaths reported in 2022 alone, and the disease's rapid spread driven by urbanization, inadequate vector control, and climatic conditions favoring Aedes aegypti proliferation in densely populated areas such as Taxila. While hematological and biochemical derangements including thrombocytopenia, leukopenia, raised hematocrit, and elevated liver transaminases are recognized as critical indicators of dengue severity and are essential for guiding clinical management, locally specific data characterizing these parameters across different severity grades in Taxila and its surrounding districts remain scarce and underrepresented in the scientific literature. Most available Pakistani studies on dengue hematological profiles are concentrated in major urban centers such as Lahore, Islamabad, and Karachi, leaving a significant evidence gap for smaller but heavily affected urban tehsils like Taxila where population density and environmental conditions sustain recurrent dengue outbreaks. This study therefore aimed to identify the pattern of hematological and biochemical parameters including hemoglobin, hematocrit, platelet count, leukocyte count, and alanine transaminase levels in dengue-positive patients presenting to HIT Hospital Taxila, and to examine their correlation with disease severity across demographic subgroups. The objective of this study was to identify the pattern of dengue fever in relation to the hematological and biochemical parameters of patients who presented to Heavy Industries Taxila Cantt (HIT) Hospital, with the aim of examining the correlation between these parameters of dengue patients in the vicinity of Taxila.

METHODS

Institutional Review Board Approval was taken from the research committee of Heavy Industries Taxila institute of medical sciences (HITEC-IMS) under reference number HITEC-IRB-35-2023. After obtaining the necessary approvals, a retrospective cross-sectional study was conducted, including all 118 patients who presented to HIT Hospital, Taxila Cantt, between August 2022 and November 2022 and tested positive for dengue serology. Informed consent was obtained from each patient during their hospital stay, ensuring their agreement to use information related to their clinical features, laboratory parameters, treatment, and outcomes for future research purposes. Patients were divided into three groups: Group-I, representing mild dengue fever; Group-II, representing moderate dengue fever; and Group-III, representing severe dengue fever. Mild dengue fever: Patients who test positive for dengue have normal hematocrit and platelet counts. Moderate dengue fever: Dengue-positive patients with raised hematocrit or low platelet count. Severe dengue fever: Dengue-positive patients with warning signs along with plasma leakage, shock, fluid accumulation, severe bleeding, and respiratory distress [14]. All the patients with positive dengue serology, regardless of their age, gender, or other parameters were included. However, patients with thrombocytopenia resulting from other hematological diseases were excluded from study. Demographic characteristics and biochemical parameters were studied. Blood samples were collected through venipuncture from the antecubital vein using a sterile syringe or vacuum collection system. A tourniquet was applied to facilitate

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vein identification, and approximately 3–5 mL of blood was drawn per patient. The blood was then processed using an automated hematology analyzer for parameters like hemoglobin, hematocrit, platelet count, and leukocyte count, while ALT levels were measured using a biochemistry analyzer. Once collected, the samples were processed and stored according to standard laboratory procedures, ensuring accuracy in the analysis of hematological and biochemical parameters. Demographic data including gender, age distribution, marital status, education, and occupation of patients while, biochemical parameters including hemoglobin (Hb) level (10-14 gm/dl), hematocrit (40-50%), platelets (150,000-400,000/ µl), leucocyte count (45,00 to 11000// µl), and plasma Alanine transaminase (ALT) levels (4-36// µl) were checked from collected blood samples of the patient. The sample size of 118 patients, while sufficient for preliminary analysis, may not be large enough to capture the full variability in hematological and biochemical parameters among dengue patients but detailed and accurate data collection from 118 patients enabled robust analysis of hematological and biochemical patterns in dengue. The sample size was calculated using the Open-Epi software, based on a population size of 56,590 individuals who could have dengue. The calculation considered an expected proportion (p) of 0.5, which represents the maximum variability in the population, ensuring the sample would capture a broad range of responses. The study aimed for a 95% confidence level (Z value = 1.96) and a 5% margin of error (E = 0.05), which is standard for health-related research. These parameters ensured that the sample size was sufficient for accurate and reliable analysis of the data on dengue severity and related biochemical parameters. The data were collected and analyzed using SPSS version 23.0. Confidence interval was targeted at 95 % with 5 % margin of error. The effect size for this study was determined based on expected differences in key hematological and biochemical parameters, such as platelet count and hematocrit, between dengue severity groups. From existing literature, moderate to large effect sizes (e.g., Cohen's *d*=0.5–0.8) were anticipated, reflecting clinically meaningful variations. This guided the analysis and interpretation of the observed findings. The quantitative data were analyzed in the form of mean, median, and standard deviation. The chi-square test of significance was applied and the p-value <0.05 was considered significant. The chi-square test was used in this study to analyze associations between categorical variables, as it is well-suited for assessing the independence or relationship between two categorical datasets. This non-parametric test is appropriate given the nature of the variables and the study's objective to identify significant patterns in patient outcomes.

RESULTS

Among the 118 dengue cases reported at HIT Hospital, Taxila, with confirmed diagnoses from August 2022 to November 2022, there were 14 patients classified as group I (mild dengue), 87 patients in group II (moderate dengue), and 17 patients in group III (severe dengue). There were 77 male patients (65.3%) and 41 female patients (34.7%). Individuals under 18 years comprised 10 (8.5%); those aged 18 to 49 years constituted 72 (61.0%); and individuals aged 50 years and above accounted for 36 (30.5%). The proportion of married patients was greater (60.8%) compared to unmarried patients (32.0%) (Table 1).

Table 1: Analysis of Demographic Variables of Patients

Demographic Variables	Groups/Subgroups	Frequency (%)
Age Group	<18 Years	10 (8.5%)
	18-49 Years	72 (61.0%)
	> 50 Years	36 (30.5%)
Gender	Male	77 (65.3%)
	Female	41 (34.7%)
Marital Status	Married	80 (68%)
	Unmarried	38 (32%)
Occupation	Student	37 (31.4%)
	Housewife	21 (17.8%)
	Employee/Job	20 (16.9%)
	Skill Person	35 (29.7%)
	Retired	5 (4.2%)
Education	Illiterate	1 (0.8%)
	Middle School	8 (6.8%)
	Primary	30 (25.4%)
	High School	61 (51.7%)
	Graduation	18 (15.3%)

Patients with severe dengue demonstrate a substantial reduction in platelet counts across all age demographics, with a p-value of less than 0.05. In persons under 18 years of age, platelet values range from 297.50 ± 33.23 in mild dengue, 118.62 ± 18.60 in moderate dengue, to 154.4 ± 7.97 in severe dengue. In the 18 to 49 age group, which constitutes the majority of individuals in the study, platelet counts are as follows: 173.83 ± 21.48 in mild dengue, 94.27 ± 22.77 in moderate dengue, and 36.50 ± 13.76 in severe dengue. In patients over 50 years old, platelet counts are as follows: 163.00±5.79 for mild dengue, 93.36±21.95 for moderate dengue, and 34.60±17.55 for severe dengue making platelet count clear and consistent marker if dengue severity. We additionally assessed other biochemical markers, including hemoglobin, hematocrit, and leukocyte count; they exhibited no significant alterations, except for total leukocyte count in individuals over 50 years, which demonstrated a p-value of less than 0.05 (Tables 2).

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Table 2: Comparison of Hemoglobin, Hematocrit, Platelets, leukocyte, ALT with Dengue Severity among Age groups

Variables	Age Groups	Dengue Severity			p-value
		Mild Mean ± SD	Moderate Mean ± SD	Severe Mean ± SD	
ALT	<18	21.00 ± 12.72	31.62 ± 9.42	29.50 ± 10.35	0.212
	18-49	72.83 ± 52.09	49.17 ± 31.09	76.08 ± 45.20	0.033
	> 50	63.50 ± 18.39	64.28 ± 33.99	80.60 ± 13.55	0.533
Hb	<18	10.90 ± 1.41	13.16 ± 0.85	0	0.016
	18-49	13.26 ± 1.75	13.50 ± 1.75	13.36 ± 1.44	0.930
	> 50	14.08 ± 1.13	13.16 ± 1.62	14.20 ± 1.15	0.217
Hematocrit	<18	0.33 ± 0.00	0.38 ± 0.03	0	0.084
	18-49	0.38 ± 0.03	0.38 ± 0.03	0.39 ± 0.02	0.782
	> 50	0.40 ± 0.01	0.39 ± 0.02	0.41± 0.01	0.220
Platelets	<18	297.50 ± 33.23	118.62 ± 18.60	154.4 ± 7.97	<0.001
	18-49	173.83 ± 21.48	94.27 ± 22.77	36.50 ± 13.76	<0.001
	> 50	163.00 ± 5.79	93.36 ± 21.95	34.60 ± 17.55	<0.001
Leukocyte Count	<18	6.40 ± 2.82	5.46 ± 2.73	0	0.677
	18-49	4.38 ± 0.96	3.86 ± 1.72	3.00 ± 1.05	0.157
	> 50	4.73 ± 1.05	3.68 ± 1.09	2.86 ± 0.89	0.022

Table 3 presented a comparison of hemoglobin (Hb), hematocrit, platelets, leukocytes, and alanine aminotransferase (ALT) levels with dengue severity among male and female participants. The data highlighted variations in these hematological and biochemical parameters across different severity levels of dengue infection, providing insights into gender-specific differences in disease progression and response.

Table 3: Comparison of Hb, Hematocrit, Platelets, Leukocyte, ALT with Dengue Severity among Male and Female Participants

Variables	Age Groups	Dengue Severity			p-value
		Mild Mean ± SD	Moderate Mean ± SD	Severe Mean ± SD	
ALT	Male	52.70 ± 22.57	47.33 ± 25.26	84.36 ± 43.89	0.001
	Female	83.25 ± 63.88	60.16 ± 40.30	64.66 ± 22.40	0.570
Hb	Male	13.65 ± 1.68	14.26 ± 1.02	14.30 ± 1.20	0.287
	Female	12.35 ± 1.69	11.77 ± 1.31	12.33 ± 0.45	0.475
Hematocrit	Male	0.38 ± 0.03	0.40 ± 0.02	0.40 ± 0.03	0.130
	Female	0.36 ± 0.03	0.36 ± 0.03	0.38 ± 0.01	0.426
Platelets	Male	190.60 ± 57.77	96.21 ± 24.92	33.27 ± 16.07	<0.001
	Female	177.50 ± 25.59	96.32 ± 19.78	40.83 ± 4.17	<0.001
Leukocyte Count	Male	5.15 ± 1.42	4.10 ± 1.99	2.87 ± 0.65	0.018
	Female	3.97 ± 0.86	3.69 ± 1.12	3.13 ± 1.47	0.467

Three out of seventeen individuals with mild dengue exhibited normal serum ALT levels, whereas eleven demonstrated abnormal levels. Among patients with moderate dengue, 27 of 87 exhibited normal serum ALT levels, whereas 60 patients presented with elevated serum ALT levels. In cases of severe dengue, 16 of 17 patients exhibited elevated serum ALT levels. In the 18 to 49 age demographic, the p-value is less than 0.05, indicating a strong link with dengue severity. In other subgroups, p-value is not significant because the sample size is insufficient (Table 4).

Table 4: Association of ALT with Dengue Severity

Variables		Dengue Severity			Total Frequency (%)	p-value*
		Mild Frequency (%)	Moderate Frequency (%)	Severe Frequency (%)		
Serum ALT	Normal (4-36)	3 (21.4%)	27 (31.0%)	1 (5.9%)	31 (26.3%)	0.001
	Not Normal	11 (78.6%)	60 (69.0%)	16 (94.1%)	87 (73.7%)	
Total		14	87	17	118	

*chi-square test

In a comparison of male and female patients with dengue severity, 71.4% of males exhibited moderate dengue, whereas 28.6% of females did. 64.4% of males experienced moderate dengue, whereas 35.6% of females did. 64.7% of males, in contrast to 35.3% of females, experienced severe dengue. Both sexes exhibit reduced platelet counts, with a p-value below 0.05 (Table 5).

Table 5: Association of Gender with Dengue Severity

Variables		Dengue Severity			Total Frequency (%)	p-value
		Mild Frequency (%)	Moderate Frequency (%)	Severe Frequency (%)		
Gender	Male	10 (71.4%)	56 (64.4%)	11 (64.7%)	77 (65.3%)	0.875
	Female	4 (28.6%)	31 (35.6%)	6 (35.3%)	41 (34.7%)	
Total		14	87	17	118	

DISCUSSION

Dengue still wreaks havoc for developing countries like Pakistan, ranging from febrile illness to multiorgan failure, and can cause death. In this study, the male population exhibited a higher prevalence than the female population, suggesting a predominance in the earlier population, potentially due to behavioral factors, biological and immunological factors, health care seeking behavior and socio-economic factors. Jayarajah U *et al.*, in 2018 studied demographic distribution and clinical and hematological findings in dengue patients from indoor patients. The study included 1167 patients (males and females). The study reported 775 cases of moderate dengue and 392 cases of severe dengue [15]. The population between 18 to 49 years of age showed a higher incidence of dengue, indicating a greater desire to earn a livelihood by venturing out and exposing themselves. Study by Prattay KM *et al.*, in 2022 showed similar results as 73.3% of patients were between 18 to 40 years of age [16]. This age group has more awareness of mosquito-borne disorders and approaches to health facilities. The majority of the population was literate, indicating the ineffectiveness of national awareness programs. Therefore, there is a need for increased government focus on educating people about mosquito-borne diseases and implementing more control programs. Jayaweckreme KP *et al.*, in 2021 notified the

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same concern in their study [17]. Most individuals showed signs and symptoms of moderate dengue, depicting its temperate and restrained presentation. Choong ZL *et al.*, in 2020 also observed same pattern on severity of disease [18]. In terms of biochemical parameters, both males and females showed a predominant loss of platelets compared to White Blood Counts (WBCs) and Red Blood Counts (RBCs). The severity of the disease increases with the decline in platelet levels. This study was concurrent with Zeeshan M *et al.*, in 2022 who demonstrated the pattern of dengue disease in 174 patients of Islamabad and Vicinity. They observed that in dengue disease 85% of patients had a platelet count of less than 100,000, and 46.8% had a reduced hematocrit. Total Leukocytes Count (TLC) was decreased in 50% of patients [19]. The virus caused damage to the liver, as evidenced by the alteration of liver enzymes from normal levels. ALT rise has an association with the severity of dengue; as it progresses, more damage is exhibited by the raised level of ALT, and this pattern was more trending in the male population as compared to females. Saghir H *et al.*, in 2022 in Islamabad conducted a study on 149 patients to assess hepatic by monitoring Alanine Transaminase (ALT) and Aspartate Transaminase (AST). They concluded that Dengue Disease (DD) is more common in males and have different pattern among patients below 30 years of age. 79 Patients with (DF) had normal ALT and 2 patients had elevated. Among 68 patients with Dengue haemorrhagic fever DHF, 41 had elevated ALT levels, and 23 patients had normal ALT levels. They found a significant correlation between platelet count and elevated ALT [20]. A study was done by Salam MA *et al.*, in 2023, to check the prevalence in the district of Rawalpindi. Blood samples were analyzed for dengue Immunoglobulin G, Immunoglobulin M, and NS1(Nonstructural protein antigen of virus) who presented with the signs and symptoms of dengue fever. 78 people were from Rawalpindi, 47 belonged to Taxila, and 35 from Kahuta [21].

This study was limited by its retrospective cross-sectional design, relatively small sample of 118 patients collected over a single dengue season from August to November 2022, and restriction to a single hospital setting, all of which constrain the temporal representativeness and geographic generalizability of findings to the broader Taxila and Rawalpindi division dengue patient population. The absence of dengue serotyping data, viral load quantification, and additional biochemical markers such as AST, lactate dehydrogenase, and coagulation profiles precluded a more comprehensive assessment of hepatic involvement and hemorrhagic risk across severity groups. Additionally, some subgroup analyses were underpowered due to small cell sizes, limiting the statistical robustness of age and gender-stratified conclusions. Future research should employ prospective multicenter designs spanning multiple dengue seasons across Taxila, Rawalpindi, and Attock districts, incorporating complete metabolic panels, dengue serotyping, and NS1 antigen quantification to enable more precise severity prediction and outbreak characterization. Longitudinal follow-up of severe dengue cases to assess post-infection hepatic and hematological recovery, combined with community-level vector surveillance studies, would provide the integrated epidemiological and clinical evidence base needed to strengthen local dengue prevention and management protocols.

CONCLUSIONS

It is concluded that dengue is more prevalent among males as compared to females, affecting the age group (18-49) mainly. Moderate dengue is more common than mild and severe forms. The majority of the patients showed reduced platelet levels, which was related to the severity. Around two-thirds of patients showed abnormal liver function tests, and the severity of dengue is concurrent with the rise of ALT. These biochemical parameters are not only helpful in assessing the disease but severity of the disease can also be uncovered.

Authors' Contribution

Conceptualization: SU, AJ, UA, SHBA, RY, MR, AJ, SS, SR
Methodology: SU, AJ, UA, SHBA, RY, MR, AJ, SS, SR
Formal analysis: SU, AJ, UA, SHBA, RY, MR, AJ, SS, SR
Writing and Drafting: SU, AJ, UA, SHBA, RY, MR, AJ, SS, SR
Review and Editing: SU, AJ, UA, SHBA, RY, MR, AJ, SS, SR

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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