The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 4, Issue 5, 2026

HEMATOLOGICAL AND BIOCHEMICAL TRENDS AMONG DENGUE PATIENTS IN PESHAWAR, PAKISTAN

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DOI: http://doi.org/10.5281/zenodo.20356611

Keywords
Dengue, Platelets count, Hematocrit, Liver enzymes, Clinical trends, Pakistan

Article History
Received: 23 March 2026
Accepted: 03 May 2026
Published: 20 May 2026

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Abstract

In this study, hospitalized patients with dengue fever from Peshawar City, Pakistan, were diagnosed to investigate the biochemical and hematological changes that are commonly observed. This was done to check the severity of the disease in early stages. Retrospective analysis is performed on the data collected from the tertiary care units of the hospital from the total 100 confirmed dengue cases. Platelets count showed a steady decline from Day 0 to Day 4, from Day 0: 148 ± 61 × 10^9/L, to Day 4: 82 ± 36 × 10^9/L; $p < 0.001$, while hematocrit and hemoglobin progressively increased, from 39.8 ± 4.1% on Day 0 to 42.3 ± 4.6% on Day 4; $p = 0.021$. Temporary impairment of the liver resulted in rise of liver enzymes (ALT, AST) on Day 2. Hematocrit and platelet count ALT ($r = -0.39$, $p = 0.015$), AST ($r = -0.33$, $p = 0.042$), and ($r = -0.46$, $p = 0.004$), seems to present significant inverse correlations as demonstrated by the result of the investigation. These findings align with classical dengue pathophysiology, highlighting thrombocytopenia and hemoconcentration as diagnostic indicators. Monitoring these parameters can improve patient management in early stages, using effective therapeutic approaches on time, according to the need of the patient's severity level, and reducing complications.

Introduction

Dengue virus (DENV) comes under arboviruses (arthropod-borne viruses) belonging to the genus Flavivirus, which further includes yellow fever virus, West Nile virus, and hepatitis C virus. (Darwish *et al.*, 2015) The primary causative agents of DENV are mosquitoes Aedes aegypti and Aedes albopictus and it is marked by a wide range of clinical symptoms ranging from mild to severe dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS) (Bhatt *et al.*, 2013; Guarner, 2019).

Globally, due to diverse factors like increasing globalization, changing climate, urbanization, and poor vector surveillance, the recorded cases have risen in the last few decades, which can be supported by the fact that dengue is now endemic to more than 100 countries and approximately 390 million people are affected by it annually (Bhatt *et al.*, 2013; WHO, 2012). Dengue is a viral disease that remains a major public health issue in tropical regions, including Pakistan. In Pakistan, dengue is a relatively recent disease in comparison with malaria but is recognized as a very concerning issue. During the last five years, the number of people infected has been escalated by tenfold in certain regions of Pakistan. (Shabbir *et al.*, 2020). The significant epidemic emerged in 2005, which later on increased both in magnitude and frequency (Khan *et al.*, 2022). Being a systematic illness, it exhibits a wide diversity of signs and symptoms.

Multiple methods have been developed to diagnose the disease, but still there are no accurate methods to predict the disease during early stages (Zhang *et al.,* 2014). Clinical features of acute dengue infection are very well known, but only a few studies have been conducted to investigate the clinical manifestation of the early recovery phase, which may potentially involve an autoimmune response in the development (García *et al.,* 2011). It is characterized by a vast clinical spectrum ranging from mild febrile illness to severe dengue hemorrhagic fever. Hematological abnormalities, including thrombocytopenia and hemoconcentration, are key diagnostic and prognostic features. Medical records of 543 cases of the historic epidemic in Campo Grande, Mato Grosso du Sul, in 2007 presented that thrombocytopenia (66.5%), lymphocytopenia (67.2%), leukopenia (68.3%), and lymphocytes (67%) were primary hematological findings. These diagnostic hematological abnormalities showed daily variation depending upon the clinical progression and severity of the disease (de Oliveira *et al.,* 2009). The liver can be diversely affected in DENV, which in disease patients is recorded by a prominent elevation in liver enzymes, particularly ALT (aspartate aminotransferase) and AST (alanine aminotransferase). According to a recent study conducted on 169 acute dengue cases in Indonesia, these two liver enzymes (AST and ALT) show the existence of a positive correlation in their levels (Hunais *et al.,* 2024).

For preventing unnecessary hospitalization, potential progression to severe dengue disease (SDD), and reducing overall disease burden, the establishment of predictive methods for early diagnosis is very crucial. In accordance with dengue guidelines (2009), weakness, abdominal pain or soreness, dizziness, nasal bleeding, and severe vomiting are warning indicators of SDD (Zhang *et al.,* 2014).

This study evaluates the dynamic changes in hematological and biochemical parameters during the course of hospitalization in dengue patients from Day 0, Day 2, and Day 4.

Materials and Methods

A retrospective study was conducted on 100 dengue-confirmed patients admitted to a tertiary care hospital in Peshawar, Pakistan. The data were collected from the emergency departments of the hospital, from both sexes (male and female) during the peak dengue season (September to October-post monsoon), primarily from-patients who were clinically diagnosed and confirmed by laboratory testing.

Data on hematological (platelet count, hemoglobin, hematocrit, WBC) and biochemical (ALT, AST) parameters were collected for Day 0, Day 2, and Day 4 of hospitalization. In order to determine the interrelationship between the variables and changes that were temporal in nature, analysis such as Pearson correlation and descriptive statistics were carried out. All of this study was conducted only after the written consent of the guardians of patients and the Ethical review committee of the institute.

Results

The individuals under observation in the study consisted of 37 females and 63 male patients with the mean age of 29.4 ± 11.8 years. The level of liver enzymes (ALT, AST) rose on Day 2 and remained elevated. Platelet count decreased from 148 ± 61 × 10^9/L at Day 0 to 82 ± 36 × 10^9/L at Day 4, while hematocrit increased from 39.8 ± 4.1% to 42.3 ± 4.6%. Analysis of the correlation between hematocrit and platelet count indicates that these two exist in a significant inverse relationship with ALT ($r = -0.39$, $p = 0.015$), AST ($r = -0.33$, $p = 0.042$), and ($r = -0.46$, $p = 0.004$) (a rise in one's level results in decrease of another factor). These findings directly reflect on the development of effective therapeutic techniques by allowing clinical treatment protocols to be accurately tailored in accordance with the demand of the patient; additionally, by acting as biological indicators they can help in the discovery of more severe forms of the disease.

Table 1. Mean laboratory parameters of dengue patients (n = 100)

Parameter	Day 0 (Mean ± SD)	Day 2 (Mean ± SD)	Day 4 (Mean ± SD)
Platelet count ($\times 10^9$/L)	148 ± 61	108 ± 48	82 ± 36
Hematocrit (%)	39.8 ± 4.1	41.6 ± 4.5	42.3 ± 4.6
Hemoglobin (g/dL)	13.0 ± 1.5	13.8 ± 1.6	14.0 ± 1.4
WBC ($\times 10^9$/L)	4.3 ± 1.1	4.0 ± 1.2	4.4 ± 1.3
ALT (U/L)	56 ± 24	92 ± 31	88 ± 28
AST (U/L)	63 ± 27	109 ± 42	102 ± 35

Table 2. Correlation between laboratory parameters

Parameter Pair	Correlation (r)	p-value
Platelet vs. Hematocrit	−0.46	0.004
Platelet vs. ALT	−0.39	0.015
Platelet vs. AST	−0.33	0.042
Hematocrit vs. ALT	+0.41	0.009

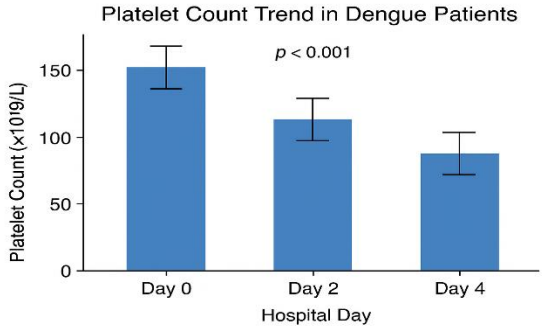

Figure 1. Trend of Platelets Count During Dengue Infection (Mean ± SD)

Mean platelet counts declined significantly over the course of hospitalization (Day 0: 148 ± 61 × 10^9/L, Day 2: 108 ± 48 × 10^9/L, Day 4: 82 ± 36 × 10^9/L; $p < 0.001$, repeated-measures ANOVA). Error bars represent ± SD. This consistent reduction corresponds to the typical thrombocytopenia seen in dengue patients, with the lowest counts occurring witnessed on Day 4, showing peak disease severity.

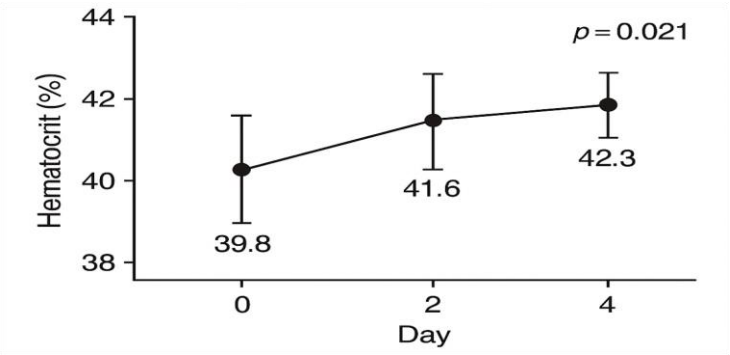

Figure 2. Trend of Hematocrit Levels During Dengue Infection (Mean ± SD)

Hematocrit levels increased progressively during hospitalization (Day 0: 39.8 ± 4.1%, Day 2: 41.6 ± 4.5%, Day 4: 42.3 ± 4.6%; p = 0.021, repeated-measures ANOVA). Error bars indicate ± SD. This upward trend reflects leakage of plasma and hemoconcentration, the hallmark of dengue infection, and inversely associated with low platelet count.

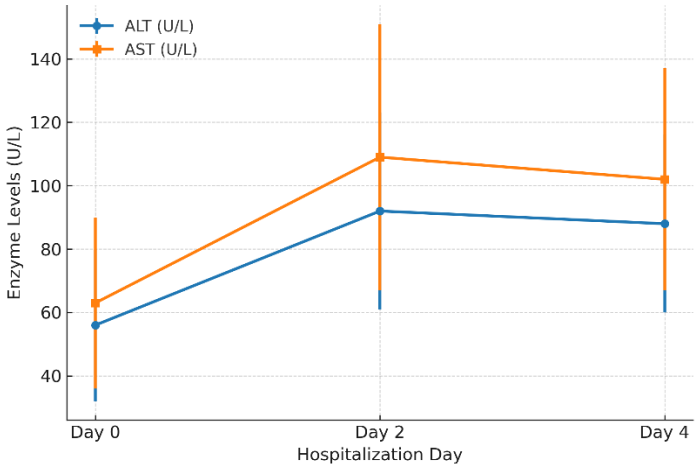

Figure 3. Variation of Liver Enzymes (ALT and AST) During Dengue Infection (Mean ± SD)

The level of both ALT and AST increased significantly during the period of hospitalization. ALT levels rose from 56 ± 24 U/L on Day 0 to 92 ± 31 U/L on Day 2, and 88 ± 28 U/L on Day 4 ($p < 0.05$). AST levels increased from 63 ± 27 U/L on Day 0 to 109 ± 42 U/L on Day 2, and 102 ± 35 U/L on Day 4 ($p < 0.05$). AST continually increases ALT, showing possible involvement of myositis or predominant hepatic stress. Error bars indicate ± SD. Day 2 proved as the most critical phase of dengue infection, due to highest level of enzyme elevations.

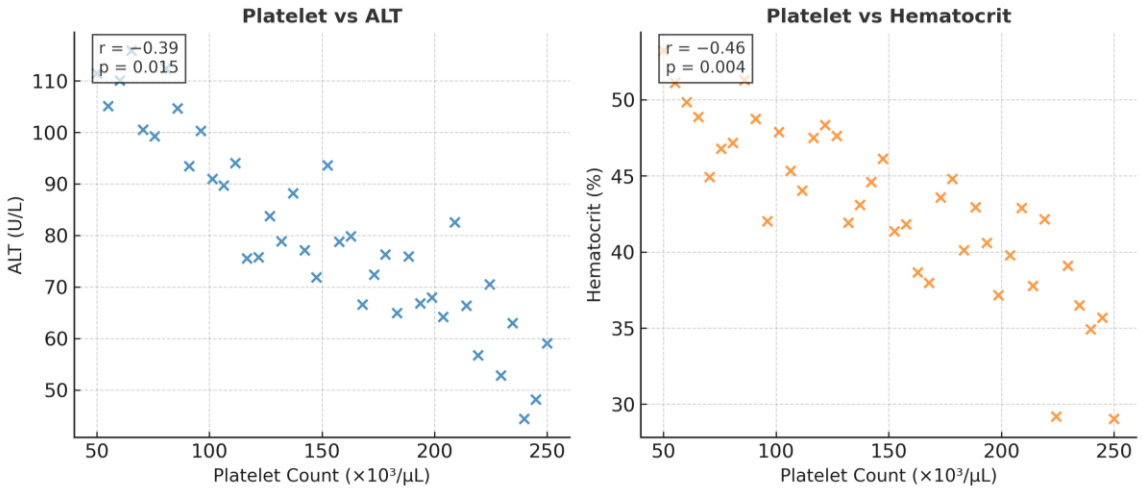

Figure 4. Correlation Between Platelet Counts, ALT, and Hematocrit

Scatter plots show the relationships between platelet counts and liver/hematological markers. Platelet count was moderately negatively correlated with ALT ($r = -0.39$, $p = 0.015$) and more strongly negatively correlated with hematocrit ($r = -0.46$, $p = 0.004$). These inverse associations indicate that as platelet levels decline, ALT and hematocrit rise, reflecting systemic involvement and increased vascular permeability in dengue infection.

Discussion

This study is focused on the discussion of typical clinical patterns of DENV, including hemoconcentration, low platelet count (thrombocytopenia), and raised levels of enzymes secreted by the liver. Investigation of all these factors is very crucial to facilitate the early diagnosis of the disease. All the participants considered in the study were with healthy hepatic conditions, showing no abnormality of the liver (Sannidhiraju *et al.,* 2025). One of the symptoms of DENV, which is very common in all viral infections, is the lemmatization of platelet counts, because the virus comes with multiple mechanisms to limit the number of circulating platelet levels (Rasizadeh *et al.,* 2024). A clear decrease in platelet count has been recorded during investigation from Day 0: $148 \pm 61 \times 10^9$/L to Day 4: $82 \pm 36 \times 10^9$/L; $p < 0.001$ (Figure 1). Research conducted in 2024 in Shenzhen, China, declared the trends in platelet alteration which comes in three patterns: the pre-decline phase (0-2 days), the decline phase (3-9 days), and the recovery phase (10-16 days). The condition of thrombocytopenia is often followed by internal bleeding, bruising, bleeding gums, and nosebleeds. Hemorrhaging in these patients is majorly caused by decreased platelets (Ojha *et al.,* 2017). Although the mechanism behind this association still eludes researchers, considerable advancements have lately been achieved (Khazali *et al.,* 2024). A variety of processes have been hypothesized to explain DENV-associated thrombocytopenia, including degradation of proximal platelets and bone marrow regression. Further, as platelets interact with DENV, endothelial cells, or immune cells, anti-platelet antibodies may also play a significant role in the destruction of peripheral platelets. Studies have also clearly revealed how DENV degrades hematopoietic precursors and stromal cells of bone marrow (Azeredo *et al.,* 2015).

Hematocrit values also climbed up progressively during hospitalization (Day 0: 39.8 ± 4.1%, Day 2: 41.6 ± 4.5%, Day 4: 42.3 ± 4.6%; p = 0.021 (Figure 2). Some individuals may face simultaneous fluctuation in their hematocrit; others may experience hemoconcentration resulting from plasma leakage (Sannidhiraju *et al.,* 2025). Blood viscosity is strongly linked with a low percentage of hematocrit or hemoconcentration, which is caused by insufficient blood plasma. Following a drop in platelet count, hemoconcentration which in dengue patients is strongly associated with vascular permeability, can happen unexpectedly. Based on the studies, there is a substantial direct proportional relationship between the severity of disease and hemoconcentration (Triana, D. (2021). According to Pathak, Chakravarty, & Krishnan 2021, in individuals with dengue; regardless of type of infection and its severity, viral load is positively correlated with hematocrit (p=0.04).

Liver involvement in dengue can be verified through symptoms such as raised levels of liver markers like AST and ALT, similar to those found in acute hepatitis caused by A, B, C, D, and E viruses having the symptoms, including pain in the right part of hepatomegaly and hypochondrium, bloating, and varied levels of jaundice (Souza *et al.,* 2007).

DENV can temporarily disrupt liver cells, resulting in the release of enzymes (AST and ALT) into the blood. During the course of this investigation, it has been witnessed that from Day 0 to Day 2 and from Day 2 to Day 4, there was a clear increase in ALT following AST level with peaked elevation on Day 2, reflecting the most critical phase of the disease (Figure 3). In a classical pattern, AST tends to increase more than ALT. Since AST is strictly liver specific, rise in its level suggests damage to the liver cells, which causes an influx of ALT directly to the bloodstream and also demonstrates vascular permeability. On the other hand, AST is not only

liver specific but can also be detected in muscles, and one of the signs of DENV is muscular inflammation (myositis), which raises AST level even higher.

Figure 5 presents the correlation between platelet count, ALT, and hematocrit. The results of the correlation between platelet count and hematocrit are -0.46 with p=0.004; between platelet and ALT level, -0.39 with p=0.015; platelet vs AST -0.33 with p=0.042; and between hematocrit and ALT +0.41 with p=0.009. The inverse correlation between platelet count and hematocrit supports the role of vascular leakage in disease pathophysiology. Elevated AST and ALT levels, with AST predominance, indicate hepatic involvement, aligning with previous reports (Martina et al., 2009; Issa *et al.*, 2014). These findings reaffirm the clinical value of serial hematological and biochemical monitoring in managing dengue patients.

Lee *et al.* (2012) reported the similar finding, indicating a positive association between DENV and raised AST and ALT levels. According to Souza *et al.* (2007), dengue not only raises levels of liver enzymes from mild to up to 30 times above normal value but also diversely damages the liver cells. Tampubolon *et al.* (2025) noted that inverse correlation between elevated hematocrit level and decreased platelet count can help in determining the clinical outcomes of disease. Similarly, Pancawati *et al.* (2025) highlighted the importance of monitoring these two parameters for enhanced medical care and the development of treatment strategies for DENV.

Conclusion

The result highlights the significance of hematological and biochemical indicators in early detection of disease for prompt medical procedures and management techniques while handling dengue patients. The investigation presents the characteristics changes in biochemical and hematological markers in dengue patients of Peshawar, including low platelets count, temporary hepatic dysfunction resulting in raised levels of liver enzymes (AST, ALT), and elevated hematocrit level. Regular assessment of these parameters can definitely help in immediate DENV management, ~~action~~, timely treatment, and reducing the complications. Future investigations on the significance of these parameters for forecasting and handling the disease patients is recommended.

Funding Statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethical Approval

The study was approved by the Ethical Review Committee of Abasyn University, Peshawar (Ethical Approval No. Ref. No. IERC-AUP-2025-041, dated 15 December 2025).

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