OPEN ACCESS

*ORIGINAL ARTICLE* *Volume 15 (Issue 2), 2026*

PAKISTAN JOURNAL OF MEDICINE & DENTISTRY

# Clinicopathological Decoding of Hyperferritinemia: Diagnostics Insights into risk stratification of Dengue Fever Patients in Tertiary Healthcare

***Durga Devi[1], Abdul Rehman Khalil Shaikh[1], Sumair Akbar Ali Memon[2], Afras Fayyaz[3], Shaista Faheem[4], Mukarram Ali[5], Fatima Ali[6]***

*[1]Department of Pathology, Liaquat University of Medical and Health Sciences, Jamshoro, [2]Department of Pathology, Muhammad Medical College, Ibn-e-Sina University, Mirpurkhas, Sindh,[3]Department of Pathology, Quaid-E-Azam Medical College, Bahawalpur, [4]Department of Medicine, Pakistan Institute of Medical Sciences Hospital, Islamabad, [5]Department of Pathology, Indus Medical College, Sindh Pakistan, [6]School of Pathology, University of Rome, Rome, Italy.*

## ABSTRACT

**Background:** Dengue fever is one of the major public health issues and clinical identification of patient who may develop severe dengue is still a challenge. The study compared the serum ferritin levels and the severity of dengue and determined the predictive ability of serum ferritin levels.

**Methods:** It is a cross-sectional study (November 2024 to April 2025) that involved 180 dengue patients diagnosed in laboratories at primary, secondary, and tertiary care institutions. The WHO 2009 criteria were used to classify the patients to Non-Severe Dengue (NSD) n=122, and Severe Dengue (SD) n=58. Upon admission, demographic, clinical and laboratory variables were obtained. ELISA was used to measure serum ferritin and independent t-test or Mann Whitney U test, Chi-square/Fisher exact test, Multivariate logistic regression, and receiver operating characteristic (ROC) curve were used for data analyses. A $p<0.05$ was set as statistically significant.

**Results:** SD patients were significantly older (35.8± 13.1 vs. 31.1± 11.9 years, p=0.032) with prolonged fever (5.3± 1.7 vs. 4.7 ±1.5 days, p=0.041)**.** SD was prevalent with abdominal pain (58.6%), persistent vomiting (41.4%), $p < 0.01$. SD patients had higher haematocrit, WBC, lower platelet counts, and elevated AST and ALT levels (all $p<0.01$). Serum ferritin levels were also higher in SD than NSD (1834.6 ± 912.5 ng/mL vs 624.8 ± 355.2 ng/mL; p<.001). Ferritin had an excellent discriminatory ability AUC (0.968; p=0.001) when analysed through ROC.

**Conclusion:** High serum ferritin is closely and independently correlated with severe dengue and has high diagnostic validity suggesting its role in early risk mapping and better management of high-risk dengue disease.

**Keywords:** Dengue Hemorrhagic Fever, Ferritins, Biomarkers, Disease Severity, Hematocrit, Thrombocytopenia, Liver Enzymes.

***Corresponding Author: Fatima Ali**

**Email:** Fmohsinali7@gmail.com

**How to cite:** Devi D, Shaikh ARK, Memon SAA, Fayyaz A, Faheem S, Ali M, et al. Clinicopathological Decoding of Hyperferritinemia: Diagnostic Insights Into Risk Stratification of Dengue Fever Patients in Tertiary Healthcare. Pak J Med Dent. 2026 April ;15(2): 122-134. Doi: https://doi.org/10.36283/ziun-pjmd15-2/011.

**Received:** Mon, February 02, 2026 **Accepted:** Tue, April 07, 2026 **Published:** Mon, April 13, 2026

## INTRODUCTION

Dengue fever is among the fastest growing viral infections spread by the mosquitoes and about 100-400 million cases of this illness are reported annually in the tropical and subtropical areas [1,2]. Clinical

spectrum of the disease is wide extending to an asymptomatic infection to severe dengue with leakage of plasma, bleedings, and dysfunction of the organs [3]. The timely detection of patients who are at-risk of severe disease is essential, especially in the resource-scarce environment where the influence of timely triage on morbidity and fatalities can be detrimental [4]. Many biomarkers have also been tested to predict disease severity; however, many are expensive, lack sensitivity, or are not regularly available in a variety of healthcare systems [5].

Serum ferritin is an intracellular iron-storing protein as well as acute-phase reactant, which has been receiving growing interest as a possible indicator of hyperinflammation in viral and immune-mediated diseases [6]. High levels of ferritin, which are considered to indicate macrophage activation, cytokine overproduction, and oxidative stress, are thought to indicate important aspects of the pathophysiology of severe manifestations of the disease in dengue infection [7]. A number of studies have indicated a large increase in the levels of ferritin in patients with severe dengue relative to non-severe cases, but the results differ substantially across different populations, laboratory protocols, and clinical settings [8,9]. Furthermore, the existing literature has no standardized conception of ferritin cut-off values, and there is a dearth of research that studied its predictive power in a systematic way with various healthcare resource settings of diverse resource pools and caseloads. This contradiction brings out a notable gap in terms of the applicability and use of ferritin as a risk-stratification tool in the management of dengue [10].

The purpose of this study was to assess the relationship between serum ferritin level and disease severity in dengue fever under different healthcare settings and prove its possible application as an available biomarker, to assist in making early clinical decisions.

## METHODS

This cross-sectional analytical study (November 2024 to April 2025) enrolled 180 dengue patients within the first, second, and third level of healthcare services with their classification based on WHO 2009 criteria into Non-Severe Dengue (NSD, n=122, 67.8%) and Severe Dengue (SD, n=58, 32.2%) after an ethical approval at Department of Infectious Diseases and pathology, IMDC and LUMHS, Sindh Pakistan (Ref: IMDC/MS/37/2024). The OpenEpi version 3.0.0 (Atlanta, GA, USA) was used in calculating the sample size based on an 80% power, 95% level of confidence and an anticipated prevalence of severe dengue based on past literature [11]. The sample size was 180 participants. A consecutive sampling method was used, including all qualified dengue patients who were presenting in the study time.

Inclusion criteria involved the patients aged ≥12 years and having dengue infection (NS1 antigen or IgM/IgG serology) confirmed by the laboratory. Exclusion criteria involved patients with chronic liver disease and hematological malignancies, autoimmune disease, and pre-existing inflammatory disease, pregnancy and patients taking iron supplements or corticosteroid therapy. Initial screening was performed using clinical history, baseline laboratory tests, and review of confirmatory diagnostic reports. The study categorized the participants into Non-Severe Dengue (NSD) and Severe Dengue (SD) based on the WHO 2009 criteria. Patients with no warning signs or some warning signs (abdominal pain, intractable vomiting, mucosal bleeding, clinical fluid accumulation, increasing hematocrit and falling platelets) were included in NSD. The patients with severe plasma leakage or respiratory distress, severe bleeding that was necessitating intervention, or severe organ involvement such as AST/ALT ≥1000 U/L or impaired consciousness were involved in SD.

Group allocation was based on clinical assessment and admission laboratory results. The structured proforma was used to record the demographic variables (age, gender), clinical variables (fever duration, abdominal pain, vomiting), and the laboratory parameters (hematocrit, platelet count, WBC count, AST, ALT, serum ferritin). Aseptic venous blood samples were collected in the morning. Measurement of serum ferritin levels was done at admission prior to commencement of treatment. The serum ferritin was determined using the Elecsys Ferritin assay (Roche Diagnostics GmbH, Mannheim, Germany) on a Cobas e immunoassay analyzer according to the protocol of the manufacturer. The amount of hematocrit, the number of platelets, the number of WBCs, and the liver enzymes were studied with the help of the automated analyzers in accordance with the internal quality-control procedures.

The data were entered, cleaned and ensured that they were complete. The SPSS version 26 (IBM Corp., Armonk, NY, USA) was used to perform the statistical analysis. The continuous variables (age, fever time, hematocrit, platelet count, WBC count, AST, ALT, serum ferritin) were demonstrated as Mean SD. As the serum ferritin had a skewed distribution, median and interquartile range (IQR) were also computed using independent t-test that compared normally distributed continuous variables between NSD and SD groups and Mann Whitney U test when the variables were non-normally distributed. Categorical variables (gender, abdominal pain, persistent vomiting, ferritin cut-off categories above 1000 ng/mL and above 1500 ng/mL) were represented as the number (percentage) and compared by means of Chi-square or Fisher exact test.

Univariable analysis was performed to determine the variables that are significantly correlated with severe dengue. The clinical meaningful variables and statistically significant variables were incorporated in a multivariate binary logistic regression model to identify independent predictors of

severe dengue. Adjusted odds ratios (aORs) and confidence intervals (CI) were obtained. Continuous data were collected as age and predetermined lab parameters, whereas serum ferritin was dichotomized based on a clinically significant cut-off level (>1000 ng/mL). Receiver operating characteristic (ROC) curves were calculated to assess the discriminating power of serum ferritin to predict severe dengue. The 95% confidence interval area under the curve (AUC) was computed and the optimal cut-off value was found by using younden index. A p-value less than 0.05 was deemed to be statistically significant.

## RESULTS

There were 180 patients in total who participated in the study by having laboratory-confirmed dengue infection. According to the WHO 2009 classification, 122 patients (67.8%) were classified as Non-Severe Dengue (NSD), and 58 patients (32.2%) as Severe Dengue (SD). The average of study population was 32.6 ±12.4 with 112 (62.2) males and 68 (37.8) females. Every participant was thoroughly assessed with a baseline laboratory test, such as hematocrit, platelet count, liver enzymes, and serum ferritin. The demographic and clinical characteristics of the population that was studied are summarized in **Table 1**. It compares age, gender, duration of fever, presence of abdominal pain and persistent vomiting in NSD and SD cohorts.

**Table 1: Demographic and Clinical Characteristics of Patients (n = 180)**

| Variable | Total (n=180) | NSD (n=122) | SD (n=58) | p-value |
|---|---|---|---|---|
| Age (years), Mean ± SD | 32.6 ± 12.4 | 31.1 ± 11.9 | 35.8 ± 13.1 | 0.032* |
| Gender, n (%) | | | | |
| Male | 112 (62.2) | 72 (59.0) | 40 (69.0) | 0.274 |
| Female | 68 (37.8) | 50 (41.0) | 18 (31.0) | |
| Fever duration (days), Mean ± SD | 4.9 ± 1.6 | 4.7 ± 1.5 | 5.3 ± 1.7 | 0.041* |
| Abdominal pain, n(%) | 63 (35.0) | 29 (23.8) | 34 (58.6) | <0.001* |

| | | | | |
|---|---|---|---|---|
| Persistent vomiting, n(%) | 51 (28.3) | 27 (22.1) | 24 (41.4) | 0.006* |

*NSD = Non-Severe Dengue; SD = Severe Dengue; SD = Standard Deviation; Significant at p < 0.05.*

The laboratory parameters were measured on the baseline to compare hematological and biochemical difference between NSD and SD groups. **Table 2** indicates that patients with severe dengue had much higher hematocrit and liver enzyme (AST, ALT) levels, and much lower platelet counts, indicating more hematological and hepatic involvement.

**Table 2: Hematological and Biochemical Parameters**

| Parameter | NSD (n=122), Mean ±SD | SD (n=58), Mean ±SD | p-value |
|---|---|---|---|
| Hematocrit | 41.2 ± 4.1 | 44.6 ± 4.8 | <0.001* |
| Platelet count (×10⁹/L) | 92.4 ± 38.2 | 48.6 ± 21.5 | <0.001* |
| WBC count (×10⁹/L) | 4.2 ± 1.7 | 5.1 ± 2.0 | 0.004* |
| AST (U/L) | 148.2 ± 101.3 | 312.7 ± 198.6 | <0.001* |
| ALT (U/L) | 129.7 ± 88.4 | 268.9 ± 156.2 | <0.001* |

*WBC = White Blood Cells; AST = Aspartate Aminotransferase; ALT = Alanine Aminotransferase, Significant at p < 0.05.*

At admission, serum ferritin was measured as a predictor of the severity of dengue. **Table 3** demonstrates that the ferritin concentration of patients in the SD group was significantly higher (1834.6 ± 912.5) than the ferritin concentration of patients in the NSD group (624.8 ± 355.2), indicating that ferritin and its concentration have a strong relationship with disease severity.

**Table 3** shows the distribution of serum ferritin levels of patients with Non-Severe Dengue (NSD) and Severe Dengue (SD) upon hospital admission. To consider skewed distribution, ferritin values are presented in mean standard deviation and median with an interquartile range (IQR). Risk stratification is evaluated with the help of categorical stratification based on clinically relevant ferritin thresholds (>1000 ng/mL and >1500 ng/mL). The odds-ratio (OR) and the 95% confidence interval (CI) demonstrate the degree of association between hyperferritinemia (>1000 ng/mL) and severe dengue. Independent t -test or Mann -Whitney U test was used to find statistical significance with continuous variables, and Chi-square test with categorical variables. A p-value less than 0.05 was considered to be statistically significant.

**Table 3: Serum Ferritin Levels and Predictive Performance for Severe Dengue**

| Parameter | NSD (n=122) | SD (n=58) | p-value |
|---|---|---|---|
| Serum ferritin (ng/mL) | 624.8 ± 355.2 | 1834.6 ± 912.5 | <0.001* |
| Median ferritin (IQR), ng/mL | 540 (380–720) | 1650 (1180–2350) | <0.001* |
| Ferritin >1000 ng/mL, n (%) | 18 (14.8%) | 44 (75.9%) | <0.001* |
| Ferritin >1500 ng/mL, n (%) | 6 (4.9%) | 36 (62.1%) | <0.001* |
| Odds Ratio for SD (Ferritin >1000 ng/mL) | — | OR 17.6 (95% CI: 7.9–39.1) | <0.001 |

The level of ferritin in serum was considerably high in the patients with severe dengue than in those with non-severe disease. There was a significant increase in both the mean and the median ferritin concentration in SD group (p<0.001). A serum ferritin level of >1000 ng/mL was connected with a significantly increased risk of severe dengue (OR 17.6, 95% CI: 7.9-39.1), which emphasized that serum ferritin is a strong statistically significant predictor of early risk classifications. On multivariate analysis of the logistic regression, increasing age was positively correlated with increased odds of severe dengue (aOR 1.04 per year increase; 95% CI: 1.01–1.07; p=0.014) as shown in **Table 4**.

The findings of the multivariate binary logistic regression analysis that determined the independent predictors of severe dengue are summarised in **Table 4**. The variables that were entered into the model were chosen based on clinical relevance and statistical significance on the univariable analysis. Adjusted odds ratios (aORs) including 95% confidence intervals (CIs) are given. Continuous variables were age and lab parameters, and a clinically relevant cut-off (>1000 ng/mL) was used to categorise serum ferritin. An aOR above 1 represents odds ratio of high dengue severity, and an aOR below 1 represents protective relationship. The p-value of less than 0.05 was taken as statistical significance.

**Table 4: Multivariable Logistic Regression for Predictors of Severe Dengue**

| Variable | Adjusted OR | 95% CI | p-value |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Age (per year) | 1.04 | 1.01–1.07 | 0.014 |
| Platelet count (×10⁹/L) | 0.96 | 0.94–0.98 | <0.001 |
| AST (per 50 U/L increase) | 1.28 | 1.12–1.47 | 0.002 |
| Ferritin (>1000 ng/mL) | 12.4 | 5.3–29.1 | <0.001 |

The number of platelets had an inverse relationship with the severity of the disease, and the reduction of platelet levels was a significant contributor to the risks of having severe dengue (aOR 0.96; 95% CI: 0.94-0.98; p<0.001). High levels of aspartate aminotransferase (AST) were also independently related with severe disease (aOR 1.28 per 50 U/L increase; 95% CI: 1.12–1.47; p=0.002). It is noteworthy that hyperferritinemia (>1000 ng/mL) turned out to be the most powerful independent predictor of severe dengue by providing more than a twelve-fold risk (aOR 12.4; 95% CI: 5.3–29.1; p<0.001).

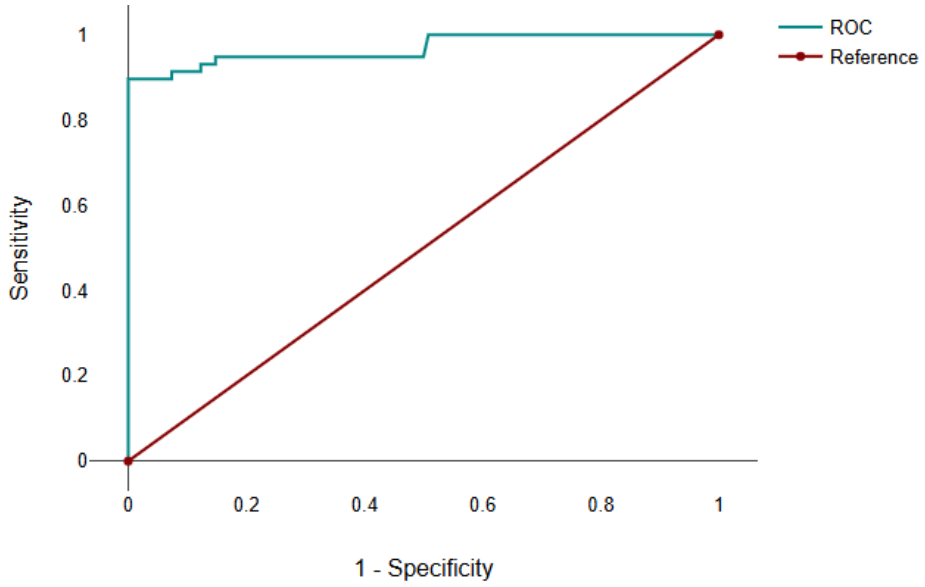


**Figure 1: Receiver Operating Characteristic (ROC) Curve for Serum Ferritin in Predicting Severe Dengue**

Receiver operating characteristic (ROC) curve demonstrating the discriminatory ability of serum ferritin for predicting severe dengue is shown in Figure 1. The area under the curve (AUC = 0.968; 95% CI = 0.687-1, SE = 0.143, p = .001) reflects the ability of ferritin to distinguish severe dengue from non-severe dengue. The optimal cut-off value was determined using the Youden index.

## DISCUSSION

In this study, the association between serum ferritin levels and severity of dengue was assessed. They were 122 (67.8%) patients with Non-Severe Dengue (NSD) and 58 (32.2%) patients with Severe Dengue (SD). More severe cases were older, experienced a longer period of fever and were more likely to have abdominal pain and persistent vomiting. The hematological assessment reported increased hematocrit, reduced platelet counts, and marginally increased WBC counts in SD. There was a significant hepatic involvement in terms of liver enzymes (AST and ALT). The serum ferritin in SD was much higher, which demonstrates a strong correlation with disease severity.

Age and chronic fever were both significantly related to SD, which is in line with previous findings that adults and older patients tend to develop a more severe disease [12]. SD was more often associated with abdominal pain and chronic vomiting, which confirms that gastrointestinal symptoms are important early signals of severe manifestations [13]. Previous studies indicating that longer duration of fever is associated with the risk of more plasma leakage and hospitalization [14, 15]. Also, some studies have proposed that male patients may have a slightly higher disease severity [16], no statistically significant gender difference was observed in the present study. Altogether, these results support the clinical significance of simple demographic and symptomatic parameters measurement to identify risks early and act accordingly [17].

High hematocrit, thrombocytopenia, and hepatic enzymes were linked to severe dengue, which supports the findings that these parameters are linked to plasma leakage, coagulopathy, and hepatic activity [18]. Moderately elevated WBC levels in SD are also consistent with the literature on the causes of severity suggesting that systemic inflammation and immune stimulation also play a role [19]. On multivariable logistic regression analysis, increasing age (aOR 1.04 per year; 95% CI: 1.01–1.07), decreasing platelet count (aOR 0.96; 95% CI: 0.94–0.98), and elevated AST (aOR 1.28 per 50 U/L increase; 95% CI: 1.12–1.47) emerged as independent predictors of severe dengue. These findings are in-line with number of investigations that have indicated that a combination of routine hematological and biochemical parameters enhances predictive power of severe dengue especially when used in conjunction with clinical warning signs [20,21]. These observations highlight the importance of risk stratification through early laboratory monitoring and make informed clinical decisions.

ROC curve analysis demonstrated excellent discriminatory ability of serum ferritin for predicting severe dengue (AUC = 0.968; 95% CI: 0.687–1.000; p = 0.001), confirming its high diagnostic accuracy. These findings support the literature reporting high levels of serum ferritin among SD patients as a biomarker of disease severity [22]. Macrophage activation, systemic inflammation, and hepatic injury in cases of severe dengue may lead to hyperferritinemia [23]. In clinical use, the

measurement of ferritin at admission can be used in the early risk stratification, early monitoring and focused therapy [24]. The correlation revealed between ferritin and other hematological and biochemical indicators implies that this parameter may be combined with other parameters and be represented in multi-parameter severity scores. Ferritin can also indicate underlying immunopathogenesis, which can provide information regarding the possible therapeutic interventions [25].

There are several limitations to this research. Its cross-sectional design did not allow the evaluation of variations in ferritin or laboratory markers through time. The sample size was sufficient but confined to one geographical location which might influence the extent of generalization. Also, other inflammatory markers were not assessed, which restricted the scope of knowledge of immunopathogenesis. Future research needs to use longitudinal designs, larger multi-centre cohorts and measure other biomarkers to support ferritin as a predictive biomarker of severe dengue and to improve early risk-stratification measures.

## CONCLUSION

This study not only reaffirms the link between elevated ferritin and severe dengue but also establishes a practical cut-off (>1000 ng/mL) that predicts a 12-fold higher odds of severe outcomes (plasma leakage, thrombocytopenia, and hepatic injury). Severely diseased patients were older, experienced a longer period of fever, and were more likely to report abdominal pain and chronic vomiting. Severe cases were further identified by hematological and biochemical evidence, such as increased hematocrit, reduced platelet counts, and an increase in liver enzymes. Serum ferritin could be an effective predictor dengue after adjustment for age, platelet count, and liver enzymes, for the stratification of high-risk dengue patients in their early stages, to provide timely monitoring and intervention. The addition of ferritin measurement to standard clinical and laboratory values may be useful in predicting severity and managing patients in various healthcare conditions.

## LIST OF ABBREVIATION

None

## ETHICAL APPROVAL

This cross-sectional analytical study (November 2024 to April 2025) enrolled 180 dengue patients within the first, second, and third level of healthcare services with their classification based on WHO 2009 criteria after an informed consent at Department of Infectious Diseases and pathology, IMDC and LUMHS, Sindh Pakistan (Ref: IMDC/MS/37/2024).

## FUNDING

None.

## CONFLICT OF INTEREST

None.

## AUTHORS' CONTRIBUTION

All authors contributed equally as per ICMJE.

## ACKNOWLEDGMENT

None

## REFERENCES

1. Tsheten T, Clements ACA, Gray DJ, Adhikary RK, Furuya-Kanamori L, Wangdi K. Clinical predictors of severe dengue: a systematic review and meta-analysis. Infect Dis Poverty. 2021 Oct 9;10(1):123. doi: 10.1186/s40249-021-00908-2.

2. Lakshmanan C, Ranjit S, Natraj R, Venkatachalapathy P, Kumar VS, Lum LCS. Hyperferritinemia in Severe Dengue Infection: Single-Center Retrospective Cohort Study. Pediatr Crit Care Med. 2023 Sep 1;24(9):e409-e416. doi: 10.1097/PCC.0000000000003250.

3. S Y, Kt S. Serum Ferritin in Dengue Infection. Cureus. 2024 Dec 20;16(12):e76103. doi: 10.7759/cureus.76103.

4. Guo L, Gu Y, Zhang Y, Zhang H, Weng W, Wu S, et al. Platelet dynamics and thrombocytopenia in dengue fever: A prospective cohort study from Shenzhen, China. New Microbes New Infect. 2025 Aug 23;67:101624. doi: 10.1016/j.nmni.2025.101624.

5. Talukdar S, Thanachartwet V, Desakorn V, Chamnanchanunt S, Sahassananda D, Vangveeravong M, et al. Predictors of plasma leakage among dengue patients in Thailand: A plasma-leak score analysis. PLoS One. 2021 Jul 29;16(7):e0255358. doi: 10.1371/journal.pone.0255358.

6. Sivasubramanian K, Bharath R R, Vajravelu LK, Kumar D M, Banerjee A. Key Laboratory Markers for Early Detection of Severe Dengue. Viruses. 2025 Apr 30;17(5):661. doi: 10.3390/v17050661.

7. Naderian R, Paraandavaji E, Maddah AH, Keshavarzi S, Habibian A, Naderian R, et al. Pathophysiology and clinical implications of dengue-associated neurological disorders. Front Microbiol. 2025 Sep 12;16:1536955. doi: 10.3389/fmicb.2025.1536955.

8. Suresh SC, Hanumanthaiah R, Ramakrishna C, Sandeep R, Narasimhasetty PS, Ramakrishna V, et al. Serum Ferritin As a Prognostic Indicator in Adult Dengue Patients. Am J Trop Med Hyg. 2020 Dec 28;104(3):1072-1078. doi: 10.4269/ajtmh.20-1111.

9. Nayak S, Rout R, Panda B, Machipeddy M, Sharma V, Patro S. Correlation between CRP and ferritin in dengue patients: A hospital-based prospective observational study. J Family Med Prim Care. 2024 Oct;13(10):4343-4346. doi: 10.4103/jfmpc.jfmpc_396_24.

10. Mettananda C, Perera K, Nayeem N, Nayanajith M, Thewage A, Premaratna R, et al. The role of serum ferritin in predicting plasma leakage among adults and children with dengue in Sri Lanka: a multicentre, prospective cohort study. Lancet Reg Health Southeast Asia. 2025 May 28;37:100606. doi: 10.1016/j.lansea.2025.100606.

11. Bhardwaj R, Agrawal U, Vashist P, Manna S. Determination of sample size for various study designs in medical research: A practical primer. J Family Med Prim Care. 2024 Jul;13(7):2555-2561. doi: 10.4103/jfmpc.jfmpc_1675_23.

12. Goyal PK, Hissaria K, Shekhawat C. Role of Serum Ferritin as a Predictor of Dengue Severity: A Prospective Observational Study From India. Cureus. 2024 Jun 30;16(6):e63503. doi: 10.7759/cureus.63503.

13. Shukla S, Jadhav SM, Gurav YK, Parashar D, Alagarasu K. Serum ferritin level as a prognostic biomarker for predicting dengue disease severity: A systematic review and meta-analysis. Rev Med Virol. 2023 Sep;33(5):e2468. doi: 10.1002/rmv.2468.

14. Ajlan BA, Alafif MM, Alawi MM, Akbar NA, Aldigs EK, Madani TA. Assessment of the new World Health Organization's dengue classification for predicting severity of illness and level of healthcare required. PLoS Negl Trop Dis. 2019 Aug 20;13(8):e0007144. doi: 10.1371/journal.pntd.0007144.

15. Jha NP, Gupta T, Krupanandan R, Sadasivam K, Kapalavai SK, Ramachandran B. Serum Ferritin Level in Children with Severe Dengue Infection and Its Association with Outcome: A Single-center Prospective Cohort Study. Indian J Crit Care Med. 2025 May;29(5):458-462. doi: 10.5005/jp-journals-10071-24972.

16. Piperno A, Pelucchi S, Mariani R. Hereditary Hyperferritinemia. Int J Mol Sci. 2023 Jan 29;24(3):2560. doi: 10.3390/ijms24032560.

17. Finkelstein JL, Colt S, Layden AJ, Krisher JT, Stewart-Ibarra AM, Polhemus M, et al. Micronutrients, Immunological Parameters, and Dengue Virus Infection in Coastal Ecuador: A Nested Case-Control Study in an Infectious Disease Surveillance Program. J Infect Dis. 2020 Jan 1;221(1):91-101. doi: 10.1093/infdis/jiz427.

18. Sigera PC, Weeratunga P, Deepika Fernando S, Lakshitha De Silva N, Rodrigo C, Rajapakse S. Rational use of ultrasonography with triaging of patients to detect dengue plasma leakage in resource limited settings: a prospective cohort study. Trop Med Int Health. 2021 Aug;26(8):993-1001. doi: 10.1111/tmi.13594.

19. Dewan N, Zuluaga D, Osorio L, Krienke ME, Bakker C, Kirsch J. Ultrasound in Dengue: A Scoping Review. Am J Trop Med Hyg. 2021 Jan 18;104(3):826-835. doi: 10.4269/ajtmh.20-0103.

20. Marisa SF, Azad MA. Serum Ferritin Level as a Predictor of Disease Severity in Patients with Dengue Infection. SAS J Med. 2023 Jul;7:783-90. DOI: 10.36347/sasjm. 2023.v09i07.010

21. Williams V, Menon N, Bhatia P, Biswal M, Sreedharanunni S, Rawat A, et al. Serum ferritin predicts neither organ dysfunction nor mortality in pediatric sepsis due to tropical infections. Sec Ped Crit Care. 2020 Dec 3;8:607673. doi: doi.org/10.3389/fped.2020.607673

22. Moallemi S, Lloyd AR, Rodrigo C. Early biomarkers for prediction of severe manifestations of dengue fever: a systematic review and a meta-analysis. Sci Rep. 2023 Oct 14;13(1):17485. doi: doi.org/10.1038/s41598-023-44559-9

23. Xiao W, Zhang L, Zhang Y, Hu J, Zhang J, Hua T, et al. Association between serum ferritin and mortality in patients with severe fever with thrombocytopenia syndrome: A retrospective cohort study. PLoS Negl Trop Dis. 2025 May 22;19(5):e0013104. doi: doi.org/10.1371/journal.pntd.0013104

24. Polpichai N, Saowapa S, Wattanachayakul P, Danpanichkul P, Trongtorsak A, Chan SY, et al. Role of plasma exchange and combining therapies in dengue-associated acute liver failure: a systematic review of individual cases. J Clin Exp Hepatol. 2025 Jan 1;15(1):102407. doi: doi.org/10.1016/j.jceh.2024.102407

25. Thach TQ, Eisa HG, Hmeda AB, Faraj H, Thuan TM, Abdelrahman MM, et al. Predictive markers for the early prognosis of dengue severity: A systematic review and meta-analysis. PLoS Negl Trop Dis. 2021 Oct 5;15(10):e0009808. Doi: doi.org/10.1371/journal.pntd.0009808