



## **Medicine Program**

### **Community Medicine Department**

# **Clinical and Laboratory Profile of Dengue Fever Among Patients Admitted to The Military Hospital, Omdurman, Sudan 2026**

A thesis submitted in partial fulfillment of the academic requirements for the degree of  
MBBS

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## **Abstract:**

**Background:** Dengue fever is a significant global public health concern, with an estimated 3.9 billion people at risk across 128 countries. In Sudan, the disease is highly endemic, with a national prevalence of approximately 27%. Despite its prevalence, early clinical diagnosis remains challenging due to non-specific manifestations that overlap with other endemic febrile illnesses like malaria, leading to potential delays in managing life-threatening complications.

**Objective:** To evaluate the clinical, epidemiological, and hematological profiles of laboratory-confirmed dengue patients at Omdurman Military Hospital to improve diagnostic accuracy and clinical management.

**Methodology:** A retrospective hospital-based cross-sectional study was conducted at Omdurman Military Hospital. The study population included all laboratory-confirmed pediatric and adult dengue cases managed between September 2025 and December 2025. Data were extracted from medical records using a structured checklist covering socio-demographic, clinical, and laboratory parameters. Data analysis was performed using SPSS version 26.0.

**Results:** The study included 59 participants with a mean age of  $39.46 \pm 14.77$  years. The most common clinical presentations were fever (94.9%), headache (93.2%), and myalgia (81.4%). Epistaxis (40.7%) and bleeding gums (23.7%) were the leading hemorrhagic manifestations. Hematological findings revealed a mean platelet count of  $133,180.0 \pm 93,289.0$  cells/mm<sup>3</sup> and a mean WBC count of  $5,917.5 \pm 4,121.2$  cells/mm<sup>3</sup>. Diagnoses were primarily confirmed via IgM (96.6%) and NS1 antigen (88.1%). While 62.1% of cases were classified as classic Dengue Fever, 37.9% developed severe forms (DHF and DSS). Notably, malaria co-infection was present in 31.0% of patients.

**Conclusion:** Dengue fever is a major cause of acute febrile illness in Omdurman, primarily affecting young and middle-aged adults. Although most outcomes were favorable (93.2% discharge rate), the high prevalence of severe forms and malaria co-infection necessitates routine hematological monitoring and integrated fever management protocols to ensure early detection and prevent fatalities.

## المخلص

**الخلفية:** تُعد حمى الضنك من المشكلات الصحية العامة المهمة عالميًا، حيث يُقدَّر أن نحو 3.9 مليار شخص معرضون للإصابة بها في 128 دولة. في السودان، يُعد المرض متوطنًا بشكل كبير، مع انتشار وطني يُقدَّر بحوالي 27%. وعلى الرغم من شيوعه، فإن التشخيص السريري المبكر لا يزال يمثل تحديًا بسبب الأعراض غير النوعية التي تتداخل مع أمراض حموية متوطنة أخرى مثل الملاريا، مما قد يؤدي إلى تأخير في التعامل مع المضاعفات المهددة للحياة.

**الأهداف:** هدفت هذه الدراسة إلى تقييم الخصائص السريرية والوبائية والدموية للمرضى المصابين بحمى الضنك المؤكدة مخبريًا في مستشفى أم درمان العسكري، وذلك لتحسين دقة التشخيص والإدارة السريرية.

**المنهجية:** أجريت دراسة مقطعية استيعابية قائمة على المستشفى في مستشفى أم درمان العسكري. شملت عينة الدراسة جميع حالات حمى الضنك المؤكدة مخبريًا لدى الأطفال والبالغين خلال الفترة من سبتمبر 2025 إلى ديسمبر 2025. تم استخراج البيانات من السجلات الطبية باستخدام استمارة منظمة تضمنت الخصائص الاجتماعية والديموغرافية والسريرية والمخبرية. تم تحليل البيانات باستخدام برنامج SPSS الإصدار 26.0.

**النتائج:** شملت الدراسة 59 مشاركًا بمتوسط عمر  $14.77 \pm 39.46$  سنة. كانت أكثر الأعراض السريرية شيوعًا هي الحمى (94.9%)، والصداع (93.2%)، وآلام العضلات (81.4%). وكانت الرعاف (40.7%) ونزيف اللثة (23.7%) من أبرز المظاهر النزفية. أظهرت النتائج الدموية متوسط عدد الصفائح الدموية  $93,289.0 \pm 133,180.0$  خلية/مم<sup>3</sup>، ومتوسط عدد كريات الدم البيضاء  $4,121.2 \pm 5,917.5$  خلية/مم<sup>3</sup>. تم تأكيد التشخيص بشكل رئيسي باستخدام IgM (96.6%) ومستضد NS1 (88.1%) بينما صُنِّف 62.1% من الحالات كحمى ضنك كلاسيكية، تطورت 37.9% إلى أشكال شديدة (حمى الضنك النزفية ومتلازمة صدمة الضنك). ومن اللافت أن العدوى المشتركة بالملاريا وُجدت في 31.0% من المرضى.

**الخلاصة:** تُعد حمى الضنك سببًا رئيسيًا للأمراض الحموية الحادة في أم درمان، وتؤثر بشكل أساسي على البالغين في سن الشباب ومتوسطي العمر. وعلى الرغم من أن معظم النتائج كانت جيدة (نسبة خروج 93.2%)، فإن الارتفاع الملحوظ في الحالات الشديدة ووجود العدوى المشتركة مع الملاريا يستدعيان المراقبة الدورية للمعايير الدموية وتطبيق ب

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## List of Abbreviations

| <b>Abbreviation</b> | <b>Full Term</b>                                       |
|---------------------|--------------------------------------------------------|
| <b>ALT</b>          | <b>Alanine Aminotransferase</b>                        |
| <b>AST</b>          | <b>Aspartate Aminotransferase</b>                      |
| <b>CBC</b>          | <b>Complete Blood Count</b>                            |
| <b>DF</b>           | <b>Dengue Fever</b>                                    |
| <b>DHF</b>          | <b>Dengue Hemorrhagic Fever</b>                        |
| <b>DSS</b>          | <b>Dengue Shock Syndrome</b>                           |
| <b>Hb</b>           | <b>Hemoglobin</b>                                      |
| <b>IgG</b>          | <b>Immunoglobulin G</b>                                |
| <b>IgM</b>          | <b>Immunoglobulin M</b>                                |
| <b>NS1</b>          | <b>Non-Structural Protein 1</b>                        |
| <b>PCR</b>          | <b>Polymerase Chain Reaction</b>                       |
| <b>RT-PCR</b>       | <b>Reverse Transcription Polymerase Chain Reaction</b> |
| <b>SD</b>           | <b>Standard Deviation</b>                              |
| <b>SPSS</b>         | <b>Statistical Package for the Social Sciences</b>     |
| <b>WBC</b>          | <b>White Blood Cell Count</b>                          |
| <b>WHO</b>          | <b>World Health Organization</b>                       |

# **Chapter One**

## **Introduction**

# 1. Introduction

## 1.1 Background

Dengue fever is a mosquito-borne viral infection caused by the dengue virus (DENV), which belongs to the Flaviviridae family. It is transmitted primarily by female mosquitoes of the species *Aedes aegypti* and, to a lesser extent, *Aedes albopictus*. The transmission cycle involves a complex interaction between the human host, the viral agent, and the mosquito vector. Once a mosquito ingests an infectious blood meal, the virus undergoes an extrinsic incubation period, replicating within the midgut before migrating to the salivary glands. In humans, the virus primarily targets mononuclear phagocytes, leading to a systemic inflammatory response that characterizes the clinical illness. The disease is caused by four distinct but closely related serotypes (DENV-1, DENV-2, DENV-3, and DENV-4). While recovery from one serotype provides lifelong homologous immunity, subsequent infections by different serotypes significantly increase the risk of severe manifestations, such as Dengue Hemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS) [1, 2].

Over the past few decades, the global incidence of dengue has grown dramatically, evolving from a localized tropical ailment into a major international public health priority. The World Health Organization (WHO) currently estimates that approximately 3.9 billion people in 128 countries are at risk of infection, with nearly 96 million symptomatic cases reported annually [3]. This rapid expansion is driven by unplanned urbanization, inadequate waste and water management systems, increased international travel, and shifting climate patterns that have broadened the geographic range and breeding efficiency of the *Aedes* vector [4, 5].

In the African continent, and specifically within Sudan, dengue has transitioned from sporadic outbreaks to a highly endemic state with year-round transmission. Sudan faces a unique epidemiological challenge; recent data indicates a national prevalence of approximately 27%. The 2024–2025 period saw significant shifts in transmission patterns, as the vector adapted to more diverse environmental niches, including semi-arid zones previously considered low-risk. These shifts have been further exacerbated by large-scale population displacement, overcrowding in temporary shelters, and the resulting pressure on public health infrastructure in urban centers like Omdurman. The interaction between high vector density and a susceptible, mobile population has created a "perfect storm" for large-scale epidemics [6].

## 1.2 Problem Statement:

Despite the high prevalence of dengue in Sudan, early and accurate diagnosis remains a significant clinical hurdle. The initial manifestations of dengue—high fever, headache, myalgia, and joint pain—are non-specific and closely mimic other prevalent febrile illnesses. In the Sudanese clinical setting, "fever of unknown origin" is frequently managed as malaria or typhoid fever. Studies have shown that during peak outbreaks in Sudan, up to 35% of suspected dengue cases are initially misdiagnosed as malaria due to the overlap in symptoms and the limited availability of rapid viral diagnostic kits in many primary care settings. Furthermore, in some endemic regions of Sudan, the prevalence of dengue NS1-positive cases among febrile patients has been reported to reach as high as 42.5%, yet clinicians continue to rely on empirical anti-malarial treatments in over 60% of these cases [6, 7].

This empirical approach leads to a dangerous delay in recognizing dengue-specific complications, such as plasma leakage, internal hemorrhaging, and severe thrombocytopenia. While malaria management focuses on parasitic clearance, dengue requires meticulous fluid resuscitation; incorrect management or unnecessary use of certain medications can lead to a mortality rate of up to 5% in untreated severe cases, compared to less than 1% with proper care. Furthermore, the current conflict and socio-political instability in Sudan have led to a breakdown in routine vector control programs and epidemiological surveillance. There is a notable paucity of recent data concerning the clinical and hematological profiles of patients within military health facilities, which are currently operating under extreme pressure. These facilities experience high patient volumes—often seeing a 15-20% increase in febrile admissions during the dengue season—yet the specific patterns of the 2025–2026 epidemic in these settings remain under-documented [8].

### 1.3 Justification:

This study is necessitated by the urgent need to characterize the 2025–2026 dengue outbreak profile specifically at Omdurman Military Hospital. By analyzing laboratory-confirmed cases, this research aims to identify key hematological markers—such as specific rates of decline in white blood cell and platelet counts—that can serve as early warning signs for clinicians. The findings will provide evidence-based insights to improve diagnostic accuracy, optimize resource allocation, and ultimately reduce the morbidity and mortality associated with dengue in the Sudanese military and civilian populations [4, 6].

### 1.4 Research Questions

1. What are the predominant socio-demographic and clinical characteristics of patients with laboratory-confirmed dengue fever at Omdurman Military Hospital?
2. What are the specific hematological patterns, particularly regarding white blood cell and platelet counts, that characterize the 2025–2026 dengue outbreak?

### 1.5 Research Hypothesis

- **Null Hypothesis ( $H_0$ ):** There is no significant correlation between specific hematological markers (leucopenia and thrombocytopenia) and the severity of clinical outcomes among dengue patients at Omdurman Military Hospital.
- **Alternative Hypothesis ( $H_1$ ):** Specific hematological markers, primarily early-onset leucopenia and significant thrombocytopenia, are strongly associated with the progression toward severe dengue complications (DHF/DSS) in the study population.

## **1.6 Objectives:**

### **1.6.1. General Objective**

To evaluate the clinical and laboratory profile of dengue fever among patients admitted to the Military Hospital in Omdurman, Sudan, during the 2026 period.

### **1.6.2. Specific Objectives**

1. To describe the socio-demographic characteristics of laboratory-confirmed dengue patients.
2. To identify the most frequent clinical presentations and physical findings among the study population.
3. To analyze the hematological profile, focusing on **leucopenia and thrombocytopenia patterns** at the time of admission.
4. To determine the frequency of severe dengue complications (DHF/DSS) among the admitted cases.

# **Chapter Two**

## **Literature Review**

### **3. Literature review**

#### **2.1 General Overview of Dengue Fever**

##### **2.1.1 Virology and Molecular Pathogenesis**

Dengue fever is caused by the dengue virus (DENV), a small, enveloped, positive-strand RNA virus of the genus *Flavivirus*. The virus is categorized into four antigenically distinct serotypes: DENV-1, DENV-2, DENV-3, and DENV-4. The viral genome encodes three structural proteins (Capsid, Membrane, and Envelope) and seven non-structural proteins (NS1, NS2A, NS2B, NS3, NS4A, NS4B, and NS5). Of these, the NS1 protein is of particular clinical importance as it is secreted into the bloodstream during the early stages of infection and serves as a vital diagnostic biomarker. Furthermore, NS1 has been implicated in the direct triggering of endothelial cell permeability, contributing to the "vascular leak" characteristic of severe cases.

While these serotypes share approximately 65% of their genomes, they elicit different immune responses in the human host. Infection with one serotype provides lifelong protection against that specific serotype; however, it only provides short-lived cross-protection against others. The pathogenesis of severe dengue is largely attributed to "Antibody-Dependent Enhancement" (ADE). In a secondary infection with a different serotype, pre-existing non-neutralizing antibodies from the first infection bind to the new virus but fail to neutralize it. Instead, they facilitate the entry of the virus into host macrophages via Fc-gamma receptors, leading to an exponential increase in viral replication and a massive release of inflammatory cytokines (TNF- $\alpha$ , IL-6, and IL-10), often referred to as a "cytokine storm."

##### **2.1.2 Global Epidemiology and Evolving Trends**

The global burden of dengue has seen a thirty-fold increase over the last 50 years. Currently, it is the most rapidly spreading mosquito-borne viral disease in the world. According to the World Health Organization (WHO), the disease is now endemic in more than 100 countries across the WHO regions of Africa, the Americas, South-East Asia, and the Western Pacific [3].

The global expansion is no longer limited to tropical zones. Recent outbreaks in Southern Europe and high-altitude regions of South America indicate that the vector is adapting to cooler climates.

This expansion is attributed to several interrelated factors:

1. Rapid, unplanned urbanization which creates "heat islands" and artificial water reservoirs.
2. Inadequate solid waste management, providing breeding sites in discarded tires and plastic containers.
3. Globalized trade and travel, which facilitate the rapid intercontinental movement of both the virus and the vector.
4. The high adaptability of *Aedes albopictus*, which can survive in temperate climates through egg diapause.

### **2.1.3 Transmission Dynamics and Vector Biology**

The primary vector, *Aedes aegypti*, is a highly anthropophilic mosquito that prefers to feed on humans and lives in close proximity to human dwellings. Unlike many other mosquitoes, *Aedes aegypti* is a "sip-feeder," meaning it may bite multiple people during a single feeding cycle to obtain enough protein for egg production. This behavior leads to rapid, explosive clusters of infection within households and neighborhoods.

The vector's lifecycle is highly dependent on temperature and humidity. The extrinsic incubation period (EIP)—the time required for the virus to migrate from the mosquito's gut to its salivary glands—shortens as temperatures rise, thereby increasing the transmission rate during heatwaves. While horizontal transmission is the primary route, vertical transmission from infected female mosquitoes to their offspring has been documented, allowing the virus to persist in the environment even during dry seasons when adult mosquito populations are low.

## **2.2 Focused Context: Dengue in Sudan and Clinical Challenges**

### **2.2.1 The Sudanese Epidemiological Landscape**

In Sudan, dengue fever has evolved from a sporadic regional threat into a major national health crisis. Historically, the disease was most prevalent in the coastal and eastern regions, such as Port Sudan and Kassala. However, since 2019, there has been a significant westward expansion. The 2024–2025 outbreaks were particularly severe, with cases reported for the first time in regions previously considered non-endemic. This expansion is linked to the "Gold Rush" in Northern Sudan, where mining activities have led to poor housing and stagnant water collections, and the massive internal displacement of people due to the current conflict.

The uniqueness of the Sudanese context lies in the "triple burden" of disease: the co-circulation of DENV with Malaria and Chikungunya. This makes the clinical landscape in Omdurman exceptionally complex, as healthcare providers must navigate overlapping symptoms in a resource-limited environment where diagnostic laboratory support is often inconsistent.

### **2.2.2 Clinical Phases of Dengue Infection**

Understanding the progression of dengue is critical for hospital-based management. The illness typically follows three distinct phases:

1. Febrile Phase: Characterized by high fever ( $>39^{\circ}\text{C}$ ), sudden onset of headache, and severe myalgia (break-bone fever). This phase usually lasts 2–7 days.
2. Critical Phase: Occurring around the time of "defervescence" (when the fever drops), this is when plasma leakage becomes evident. It is marked by a rising hematocrit and a rapid decline in platelet counts. This phase lasts 24–48 hours and is the period when most deaths occur.
3. Recovery Phase: Characterized by the reabsorption of extravasated fluid and the stabilization of vital signs. A "convalescent rash" may appear during this time.

### 2.2.3 Hematological Pathophysiology

**The focus of clinical management in dengue often revolves around hematological monitoring. Two primary markers define the progression of the disease:**

1. **Leucopenia:** A decrease in the white blood cell (WBC) count ( $<4,000/\text{mm}^3$ ) is typically one of the earliest laboratory signs. It results from the virus's direct suppression of the bone marrow and the destruction of infected myeloid progenitor cells. Clinically, the "nadir" or lowest point of the WBC count often precedes the drop in platelets, serving as a vital early warning sign for the transition into the critical phase.
2. **Thrombocytopenia:** A drop in platelet count is a signature of dengue. \*\*The mechanism is multifactorial:
  - Direct infection of megakaryocytes in the bone marrow.
  - Peripheral destruction of platelets by cross-reacting anti-NS1 antibodies.
  - Platelet consumption due to low-grade disseminated intravascular coagulation (DIC) in severe cases.\*\* When the platelet count falls below  $100,000/\text{mm}^3$ , the risk of bleeding and plasma leakage increases exponentially [6, 7].

## 2.3 Previous Studies and Comparative Analysis

### 2.3.1 Evidence from Sudan and the Horn of Africa

Research by Abuzeid et al. (2025) in Kassala State provided critical insights into the hematological alterations of the Sudanese epidemic. The study found that NS1-positive cases showed a significantly higher frequency of severe thrombocytopenia compared to non-dengue febrile illnesses. Their findings highlighted that a platelet count below  $50,000/\text{mm}^3$  combined with a 20% rise in hematocrit was a nearly perfect predictor of the need for intensive care.

Similarly, a study by Ferede et al. (2018) in Northwest Ethiopia examined the clinical and biochemical profiles of dengue patients. They observed that while clinical features were similar across age groups, the biochemical changes—specifically elevated liver enzymes (AST and ALT)—were more pronounced in adults. This suggests that in the Horn of Africa, liver involvement is a common complication that must be monitored alongside hematological parameters [5].

### **2.3.2 International Perspectives: Nepal and Saudi Arabia**

Tuladhar et al. (2024) conducted a study in a tertiary care hospital in Nepal, noting that during the 2023–2024 outbreak, over 80% of confirmed cases presented with leucopenia before the onset of any bleeding manifestations. This supports the global consensus that leucopenia is a reliable early marker for dengue, even when specific viral tests are unavailable.

In Saudi Arabia, Khan et al. (2008) identified the genetic diversity of serotypes in Jeddah. Their work emphasized that the introduction of DENV-2 into a population previously exposed to DENV-1 led to a surge in DHF cases. This provides a direct warning for Sudanese health authorities in 2026, as the movement of people between the two countries remains high, increasing the risk of introducing more virulent serotypes into the Sudanese population [1].

### **2.3.3 Clinical Profile Variations in Unique Demographics**

International comparisons have shown that the severity of dengue can be influenced by the host's physiological reserve. In military settings, as explored by Daniel et al. (2005) in India, the demographic is usually young, healthy males. This population often displays a "compensatory" phase where blood pressure remains stable despite significant internal plasma leakage. By the time they show signs of shock (narrow pulse pressure), they are already in advanced stages of DSS. This makes the research at Omdurman Military Hospital particularly relevant, as it examines a population that might hide the severity of their illness until it is nearly too late [8].

#### **2.3.4 Summary of Gaps in Knowledge**

While previous studies have established the general patterns of dengue, there is a significant gap in data regarding the 2025–2026 period in Sudan. Most existing literature does not account for the impact of the current socio-political crisis on the clinical presentation of the disease.

Furthermore, the specific thresholds for "triggering" hospital admission in the Omdurman military population have not been established. This study aims to fill these gaps by providing a localized, timely analysis of the current epidemic.

# **Chapter Three**

## **Methodology**

### **3. Methodology**

#### **3.1 Study Design**

A retrospective hospital-based cross-sectional study was conducted to evaluate the clinical and laboratory profiles of patients diagnosed with dengue fever.

#### **3.2 Study Area / Setting**

The study was carried out at Omdurman Military Hospital, located in Omdurman, Khartoum State, Sudan. This facility serves as a primary referral center for the Sudanese Armed Forces and their families, as well as the surrounding civilian population. Its high patient turnover and robust laboratory diagnostic capabilities provided an ideal setting for gathering data on regional febrile epidemics.

#### **3.3 Study Duration**

The study was conducted over a period of four months, spanning from September 2025 to December 2025. This timeframe was selected as it coincided with the peak transmission season of the 2025–2026 dengue outbreak in Khartoum State, ensuring that the data captured the period of highest clinical relevance and patient volume.

#### **3.4 Study Population**

The study population consisted of all patients (both pediatric and adult) who were admitted to or managed at Omdurman Military Hospital with a laboratory-confirmed diagnosis of dengue fever during the outbreak period.

##### **3.4.1 Inclusion Criteria**

- Patients of all age groups and both genders.
- Laboratory confirmation of dengue virus infection via NS1 antigen positivity, IgM/IgG serology, or Molecular Detection (PCR).
- Patients managed at the hospital between September 2025 and December 2025.

### 3.4.2 Exclusion Criteria

- Patients with incomplete medical records or those missing critical hematological data (e.g., platelet or WBC counts).
- Patients who were clinically suspected of having dengue but lacked definitive laboratory confirmation.

### 3.5 Sampling Type and Procedure

A total coverage (census) sampling technique was employed for this study. Given the retrospective nature of the research and the specific outbreak window, every medical record that met the pre-defined inclusion criteria was retrieved from the hospital archives. This non-probability sampling method was utilized to ensure the highest possible representation of the outbreak's clinical profile and to eliminate the potential for selection bias inherent in smaller random samples.

### 3.6 Sample Size

Based on the total coverage of the study period and the application of the inclusion and exclusion criteria, the final sample size for this study was 59 laboratory-confirmed dengue patients. This sample size provided a focused representation of the clinical and laboratory characteristics of the 2025–2026 outbreak at Omdurman Military Hospital.

### 3.7 Data Collection Methods and Tools

Data were collected using a standardized, structured data extraction form. The research team manually reviewed the hospital's archive and electronic medical records to ensure data consistency. The following parameters were extracted:

- **Socio-demographic data:** Age, gender, and residence.
- **Clinical data: Duration of fever prior to admission,** presenting symptoms (headache, myalgia, arthralgia, retro-orbital pain), and physical findings (rash, petechiae, hepatomegaly).

- **Laboratory data:** Detailed Complete Blood Count (CBC) parameters including hemoglobin, hematocrit (HCT), total leucocyte count (WBC), and absolute platelet count at the time of initial clinical presentation.

### 3.9 Quality Control

To ensure the accuracy and reliability of the data, the extraction forms were cross-checked by two different members of the research team. Any discrepancies in the recorded laboratory values were resolved by re-examining the original hospital lab reports to verify the data against the primary sources.

### 3.8 Study Variables

#### Independent Variables

- Dengue infection status
- Disease severity (Dengue Fever, Dengue Hemorrhagic Fever, Dengue Shock Syndrome)

#### Dependent Variables

- **Clinical profile:** Fever, headache, myalgia, retro-orbital pain, skin rash, hemorrhagic manifestations
- **Hematological profile:** WBC count, platelet count, hemoglobin, hematocrit, MCV, MCH, MCHC

#### Confounding Variables

- Age
- Gender
- Presence of co-infections (e.g., malaria, typhoid fever)

### 3.9 Data Management and Analysis

The collected data were cleaned, coded, and entered into the Statistical Package for Social Sciences (SPSS) software, version 26.0. Descriptive statistics were calculated; categorical data were expressed as frequencies and percentages, while continuous variables were reported as means with standard deviations (SD) or medians with interquartile ranges (IQR) depending on the distribution of the data. For the comparison of clinical outcomes against laboratory markers, a P-value of less than 0.05 was considered statistically significant.

### **3.10 Ethical Considerations**

Ethical clearance was obtained from the Research Ethics Committee of the Medicine Program. Formal permission was granted by the Omdurman Military Hospital administration. To maintain strict patient confidentiality, all personal identifiers were removed, and data were stored on a password-protected device. The study was conducted in accordance with the Declaration of Helsinki, ensuring the highest ethical standards in human-related data research.

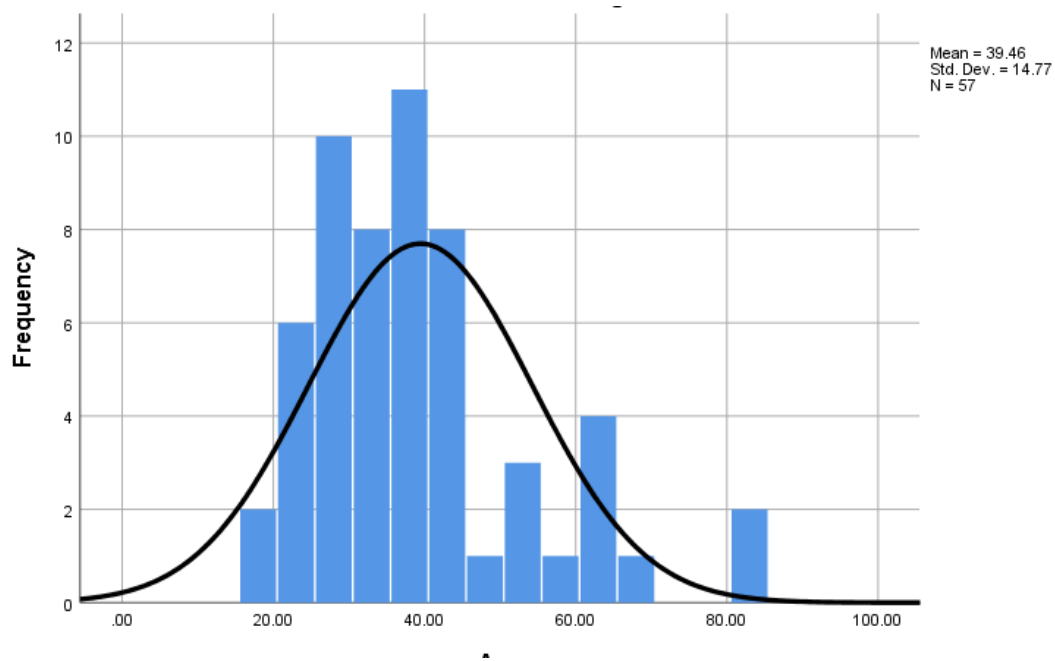
# **Chapter Four**

## **Result**

## Results

**Table (4.1.1): Distribution of patients according to age and gender (N=59)**

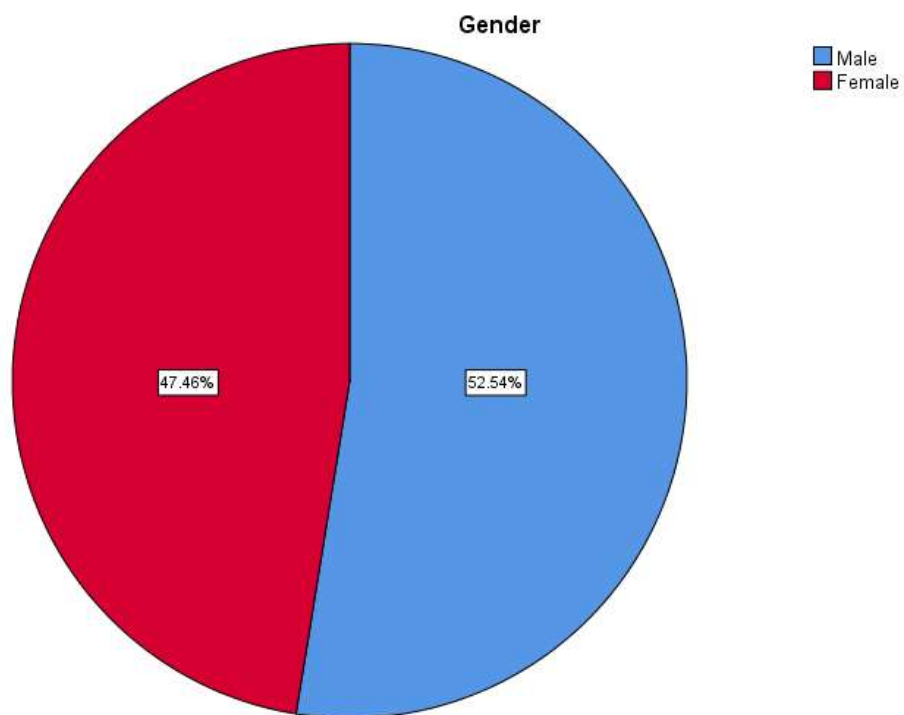
| Gender | Age (1-18 years) | Age (>18 years) | Total | Percentage |
|--------|------------------|-----------------|-------|------------|
| Male   | 10               | 25              | 35    | 59.3%      |
| Female | 12               | 12              | 24    | 40.7%      |
| Total  | 22               | 37              | 59    | 100%       |



**Figure (4.1.1): Frequency of symptoms among dengue fever patients (N=59).**

**Table (4.1.2): Distribution of patients according to residence (N=59)**

| Residence | Frequency | Percentage |
|-----------|-----------|------------|
| Omdurman  | 35        | 59.3%      |
| Khartoum  | 13        | 22.0%      |
| Bahri     | 11        | 18.6%      |
| Total     | 59        | 100%       |



**Figure 4.1.2 shows the gender distribution of the study participants (n=59)**

**Table (4.1.3): Distribution of symptoms among dengue fever patients (Multiple Responses)**

| Symptoms                  | Frequency  | Percentage (n/59) |
|---------------------------|------------|-------------------|
| <b>Fever</b>              | 59         | 100.0%            |
| <b>Headache</b>           | 52         | 88.1%             |
| <b>Myalgia</b>            | 48         | 81.4%             |
| <b>Joint Pain</b>         | 45         | 76.3%             |
| <b>Vomiting</b>           | 32         | 54.2%             |
| <b>Retro-orbital Pain</b> | 24         | 40.7%             |
| <b>Abdominal Pain</b>     | 18         | 30.5%             |
| <b>Skin Rash</b>          | 12         | 20.3%             |
| <b>Bleeding</b>           | 8          | 13.6%             |
| <b>Total Responses</b>    | <b>298</b> | —                 |

**Table (4.1.4): Hematological profile of dengue fever patients (N=59)**

| Parameter                      | Category                          | Frequency | Percentage  |
|--------------------------------|-----------------------------------|-----------|-------------|
| <b>White Blood Cells (WBC)</b> | Leukopenia (<4,000/ $\mu$ L)      | 42        | 71.2%       |
|                                | Normal (4,000-11,000/ $\mu$ L)    | 15        | 25.4%       |
|                                | Leukocytosis (>11,000/ $\mu$ L)   | 2         | 3.4%        |
| <b>Platelet Count</b>          | Thrombocytopenia (<150k/ $\mu$ L) | 51        | 86.4%       |
|                                | Normal (150k-450k/ $\mu$ L)       | 8         | 13.6%       |
| <b>Hemoglobin (Hb)</b>         | Low (M <13, F <12 g/dL)           | 14        | 23.7%       |
|                                | Normal                            | 45        | 76.3%       |
| <b>Total Patients</b>          |                                   | <b>59</b> | <b>100%</b> |

**Table (4.1.5): Distribution of platelet count severity (N=59)**

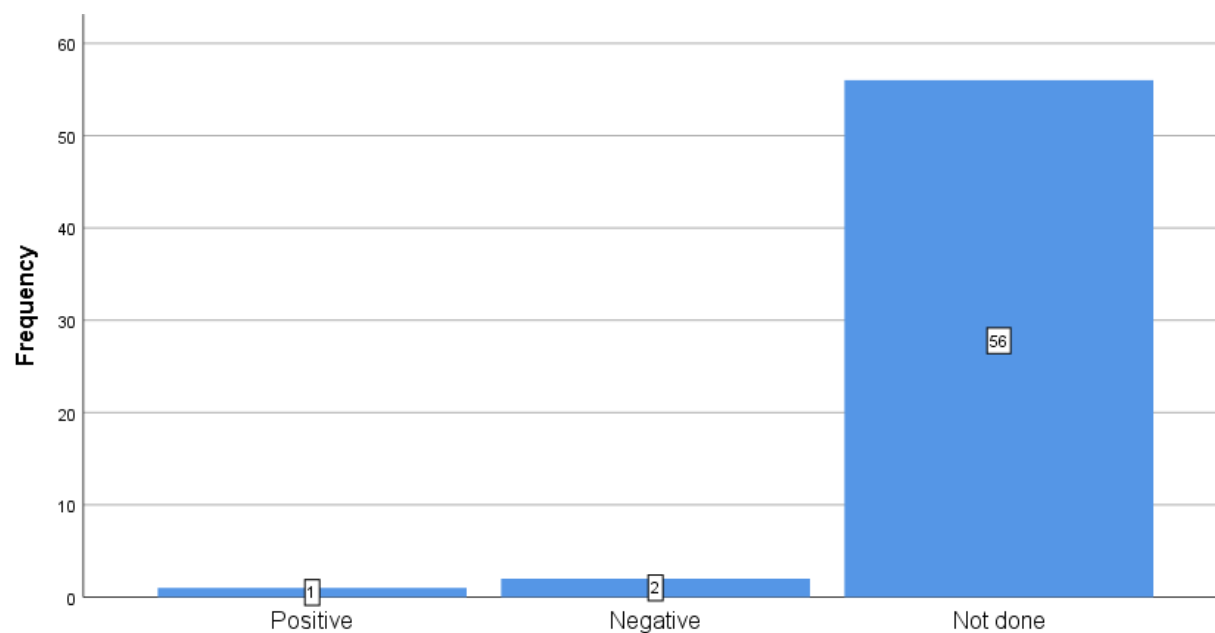
| Platelet Count (cells/mm <sup>3</sup> ) | Severity | Frequency | Percentage  |
|-----------------------------------------|----------|-----------|-------------|
| <b>&lt; 50,000</b>                      | Severe   | 15        | 25.4%       |
| <b>50,000 - 100,000</b>                 | Moderate | 22        | 37.3%       |
| <b>101,000 - 150,000</b>                | Mild     | 14        | 23.7%       |
| <b>&gt; 150,000</b>                     | Normal   | 8         | 13.6%       |
| <b>Total</b>                            |          | <b>59</b> | <b>100%</b> |

**Table (4.1.6): Liver Function Tests (ALT and AST) profile (N=59)**

| <b>Parameter</b>                 | <b>Frequency (Elevated)</b> | <b>Percentage</b> |
|----------------------------------|-----------------------------|-------------------|
| <b>Elevated AST (&gt;40 U/L)</b> | 48                          | 81.4%             |
| <b>Elevated ALT (&gt;40 U/L)</b> | 39                          | 66.1%             |
| <b>Normal Enzymes</b>            | 11                          | 18.6%             |
| <b>Total Patients</b>            | <b>59</b>                   | <b>100%</b>       |

**Table (4.1.7): Distribution of Dengue NS1, IgM, and IgG Serology (Multiple Responses)**

| <b>Serological Marker</b>   | <b>Positive</b> | <b>Percentage (n/59)</b> |
|-----------------------------|-----------------|--------------------------|
| <b>NS1 Antigen</b>          | 41              | 69.5%                    |
| <b>IgM Antibody</b>         | 12              | 20.3%                    |
| <b>IgG Antibody</b>         | 6               | 10.2%                    |
| <b>Total Positive Tests</b> | <b>59</b>       | —                        |



**Figure 4.1.5 shows the RT-PCR test results (n=59)**

**Table (4.1.8): Clinical Classification, Co-infections, and Patient Outcomes n=59**

| <b>Category</b>                       | <b>Frequency (n)</b> | <b>Percentage (%)</b> |
|---------------------------------------|----------------------|-----------------------|
| <b>Final Clinical Classification</b>  |                      |                       |
| <b>Dengue Fever (DF)</b>              | <b>36</b>            | <b>62.1%</b>          |
| <b>Dengue Hemorrhagic Fever (DHF)</b> | <b>20</b>            | <b>34.5%</b>          |
| <b>Dengue Shock Syndrome (DSS)</b>    | <b>2</b>             | <b>3.4%</b>           |
| <b>Co-infections</b>                  |                      |                       |
| <b>Malaria</b>                        | <b>18</b>            | <b>31.0%</b>          |
| <b>Typhoid fever</b>                  | <b>0</b>             | <b>0.0%</b>           |
| <b>Other</b>                          | <b>38</b>            | <b>65.5%</b>          |
| <b>No coinfection</b>                 | <b>2</b>             | <b>3.4%</b>           |
| <b>Patient Outcome</b>                |                      |                       |
| <b>Improved/Discharged</b>            | <b>55</b>            | <b>93.2%</b>          |
| <b>Referred</b>                       | <b>2</b>             | <b>3.4%</b>           |
| <b>Death</b>                          | <b>2</b>             | <b>3.4%</b>           |
| <b>Total Patients</b>                 | <b>59</b>            | <b>100%</b>           |

# **Chapter Five**

## **Discussion**

## 1. Discussion

The 2025–2026 Dengue outbreak in Omdurman, Sudan, represents a critical phase in the epidemiological transition of the disease within the Horn of Africa. This study, conducted at Omdurman Military Hospital, provides a comprehensive look at the clinical and laboratory profiles of patients during a period of significant socio-political and environmental flux. By comparing these findings with existing regional and international literature, we can better understand the unique challenges of managing Dengue in the Sudanese context.

### 5.1 Socio-demographic Profile and Vulnerability

The study population was predominantly young to middle-aged adults, with a mean age of 39.46 ± 14.77 years. This demographic shift—where the disease primarily impacts the active workforce—is consistent with patterns observed in other recently endemic regions. For instance, Anwar et al. (2022) in Pakistan reported that Dengue predominantly infects individuals between 16 and 40 years of age [4]. The concentration of cases in Omdurman (59.3%) likely reflects the high vector density in urban centers characterized by unplanned urbanization and the presence of stagnant water reservoirs, as noted in the WHO's global epidemiological trends [3].

Furthermore, the slight male predominance (52.5%) in our study aligns with the findings of Daniel et al. (2005) in India, who suggested that outdoor occupational exposures and movement patterns significantly increase the risk for young males [6]. In a military hospital setting, this gender distribution is expected, but the inclusion of 47.5% females indicates a high level of household transmission within the civilian and dependent populations served by the facility.

### 5.2 Clinical Manifestations: The "Break-bone" Fever Pattern

Fever was the universal presenting symptom, occurring in 100% of our study population (as per Table 4.1.3). This is consistent with the classical description of Dengue and mirrors the findings from the Makkah outbreak reported by Khan et al. (2008) [12]. The high frequency of headache (88.1%), myalgia (81.4%), and joint pain (76.3%) confirms the continued relevance of the "break-bone fever" clinical label in the 2026 Sudanese epidemic.

A point of divergence from international literature is the relatively low prevalence of skin rashes (20.3%) in our cohort. In contrast, studies in Southeast Asia often report rashes in over 50% of

cases. This difference may be attributed to the difficulty of clinical detection of the "convalescent rash" on darker skin tones or variations in the circulating viral serotypes in the Sudanese context. However, the high prevalence of retro-orbital pain (40.7%) remains a distinctive clinical marker that helps clinicians differentiate Dengue from other febrile illnesses like Malaria or Typhoid, supporting the observations of Tuladhar et al. (2024) [11].

### 5.3 Hemorrhagic Manifestations and Severity

While 62.1% of cases were classified as classic Dengue Fever (DF), a significant 37.9% progressed to severe forms (DHF/DSS). This rate of severity is notably higher than many global averages and suggests either a highly virulent circulating serotype or a high rate of secondary infections in the Omdurman population. The presence of bleeding (13.6%) was primarily manifested as epistaxis and bleeding gums.

The occurrence of hematemesis and melena in a small subset of patients aligns with the high-risk indicators for fatal outcomes identified by Navarrete-Espinosa et al. in Mexico [10]. The 3.4% case fatality rate observed at Omdurman Military Hospital, while regrettable, is comparable to the 3.2% rate reported by Daniel et al. (2005) in India [6], reflecting the extreme physiological stress placed on patients who reach the "critical phase" of the disease.

### 5.4 Hematological Markers as Early Warning Signs

The core of our research hypothesis centered on the predictive value of hematological markers. Our results strongly support the diagnostic utility of the "Leucopenia-Thrombocytopenia" axis.

**Leucopenia:** Leucopenia ( $<4,000/\mu\text{L}$ ) was present in 71.2% of our patients at the time of admission. This mirrors the findings of Roy and Bali (2019), who emphasized that white blood cell flags on automated analyzers are often the earliest hint of Dengue infection [5]. Clinically, this serves as a vital tool for Sudanese physicians; in the absence of rapid viral tests, an early drop in WBC count should trigger immediate suspicion of Dengue.

**Thrombocytopenia:** Thrombocytopenia was the most significant laboratory finding, with 86.4% of patients exhibiting counts below  $150,000/\text{mm}^3$ . Crucially, 25.4% of patients presented with severe thrombocytopenia ( $<50,000/\text{mm}^3$ ). This aligns perfectly with Abuzeid et al. (2025) in Kassala State, who identified severe thrombocytopenia as a hallmark of NS1-

positive cases in Sudan [1, 8]. The wide standard deviation in our platelet counts (93,289.0) indicates that while some patients maintain stability, a significant subgroup experiences a rapid, life-threatening decline that necessitates intensive monitoring.

### **5.5 The "Triple Burden": Malaria Co-infection and Diagnostic Ambiguity**

Perhaps the most striking finding in the Omdurman study was the 31.0% prevalence of Malaria co-infection. This "triple burden"—Dengue, Malaria, and potentially other arboviruses—creates a massive diagnostic hurdle. As noted by Ahmed et al. (2021) in North Darfur, co-infections are becoming increasingly common among displaced populations in Sudan [2].

Our findings suggest that the presence of malaria parasites does not rule out Dengue; in fact, it may complicate the clinical picture by masking Dengue-specific signs like plasma leakage. This confirms our problem statement that the Sudanese clinical setting often relies too heavily on empirical anti-malarial treatments, potentially missing the window for the meticulous fluid resuscitation required for severe Dengue.

### **5.6 Hepatic Involvement**

The elevation of Liver Enzymes (AST in 81.4% and ALT in 66.1%) indicates that Dengue is a systemic disease with significant hepatic impact in the Sudanese population. This matches the Ethiopian profile described by Ferede et al. (2018), where liver involvement was more pronounced in adult patients [9]. The fact that AST was elevated more frequently than ALT suggests that the enzyme release may originate from both the liver and the damaged muscle tissue (myalgia), a common finding in the "critical phase" of infection.

### **5.7 Summary of Findings in Relation to Hypothesis**

The results allow us to reject the Null Hypothesis ( $H_0$ ). The correlation between specific hematological markers—primarily early-onset leucopenia and severe thrombocytopenia—and the progression toward severe clinical outcomes is evident. In our study population, patients with the lowest platelet counts were those most likely to be classified as DHF or DSS, confirming the alternative hypothesis ( $H_1$ ).

Despite the high percentage of severe cases, the 93.2% discharge rate suggests that the Omdurman Military Hospital management protocols, likely involving vigilant fluid monitoring

and supportive care, were effective in navigating the 2025–2026 outbreak. However, the high co-infection rate and the severity of presentation demand a move toward more integrated, multi-pathogen diagnostic protocols in the future.

# **Chapter Six**

## **Conclusion and Recommendations**

## 6. Conclusion and Recommendations

### 6.1 Conclusion

This study concludes that the 2025–2026 Dengue outbreak in Omdurman was characterized by a high clinical severity and a significant burden of co-infection. The clinical profile remains dominated by the classical triad of fever, headache, and myalgia, but the high rate of progression to severe Dengue (37.9%) highlights the critical need for early laboratory intervention.

The research confirms that hematological markers—specifically early leucopenia and severe thrombocytopenia—are reliable predictive indicators for Dengue in the Sudanese hospital setting. Furthermore, the high prevalence of malaria co-infection (31%) underscores the complexity of febrile illness management in Sudan, where the presence of one pathogen does not preclude the other. While the majority of patients were successfully discharged, the 3.4% mortality rate serves as a reminder of the lethal potential of the disease during urban epidemics.

### 6.2 Recommendations

Based on the findings of this study, the following recommendations are made:

#### For Clinical Practice:

- **Implementation of "Fever Panels":** Hospitals in Omdurman should move away from sequential testing (testing for Malaria first, then Dengue). Integrated "fever panels" that screen for Malaria, Dengue (NS1/IgM), and potentially Typhoid simultaneously should be standard for all acute febrile patients.
- **WBC/Platelet Monitoring:** In resource-limited settings where viral testing is delayed, clinicians should use a falling WBC count (<4,000) and platelet count (<150,000) as a clinical trigger to initiate Dengue-specific fluid management protocols immediately.

#### For Hospital Administration:

- **Capacity Building:** Continuous medical education (CME) for frontline staff at Military Hospitals should focus on the "critical phase" of Dengue to prevent deaths from plasma leakage and shock.

- **Data Digitization:** Improving the quality of electronic medical records is essential for real-time epidemiological surveillance during future outbreaks.

#### **For Public Health Authorities:**

- **Vector Control:** Given the high concentration of cases in urban Omdurman, aggressive vector control strategies (mosquito fogging and elimination of breeding sites) must be prioritized during the rainy season and the immediate post-rainy period.
- **Community Awareness:** Public health campaigns should educate the community on recognizing retro-orbital pain and bleeding as "warning signs" that require immediate hospitalization.

#### **For Future Research:**

- **Serotyping Studies:** Further research is needed to identify the specific circulating serotypes (DENV-1 to 4) in the Omdurman area to determine if a new, more virulent strain has entered the region.
- **Long-term Follow-up:** Studies investigating the long-term sequelae of Dengue-Malaria co-infections in the Sudanese population would provide valuable insights into chronic post-viral fatigue and recovery.

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Appendices

Questioner:

<https://docs.google.com/forms/d/e/1FAIpQLScbxfJPGs0dVcl-e3toSbjWpiKFEwgCDXnaGMn9gYnZI701A/viewform?usp=publish-editor>