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Research Article

Determination of Malaria and Dengue Virus Frequencies in Shendi City- River Nile State-2026

**Nazeer Mohammed Daffallah Hamid¹, Alamin Abdulkareem², Sanaa M A. Osman³,
Amira Eltom Fawzi Osman⁴, Mohamed Mobarak Elbasheir⁵**

^{1,2} Department of Parasitology, Faculty of Medical Laboratory Science, Alneelain University, Khartoum, Sudan

^{3,4} Department of Microbiology, Faculty of Medical Laboratory Science, University of Alzaiem Alazhari, Khartoum, Sudan

⁵ Department of Parasitology & Medical Entomology, Faculty of Medical Laboratory Sciences, Alzaiem Alazhari University, Khartoum, Sudan

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ABSTRACT

Background: The collapse of the healthcare system during the recent armed conflict in Sudan has facilitated the emergence and expansion of vector-borne diseases, particularly malaria and dengue fever, into regions historically considered non-endemic. Population displacement, environmental disruption, and breakdown of public-health infrastructure have contributed to increased transmission and atypical epidemiological patterns. This study investigates the frequency of malaria and dengue virus infections among patients attending insurance-based medical clinics in Shendi City, River Nile State, during the outbreak period. Methods: A descriptive cross-sectional study was conducted using routinely collected clinical records from eight insurance medical clinics between December 2025 and June 2026. Extracted variables included age, sex, diagnostic modality, and infection type. Malaria diagnosis was performed using thick blood-film microscopy and immunochromatographic rapid diagnostic tests (RDTs). Dengue virus infection was assessed using immunochromatographic antigen/antibody assays. Data were analyzed using Microsoft Excel 2016. Results: Among 12,000 patients, females constituted 97.7% and adults 95.8%. Malaria positivity was 88.1% (10,576/12,000), with *Plasmodium falciparum* accounting for 99.5% of confirmed infections. Dengue virus was detected in 16.3% (1,952/12,000) of patients. All dengue-positive individuals were concurrently infected with malaria. Age-specific analysis revealed malaria positivity of 59.1% among children and 89.4% among adults, whereas dengue positivity reached 80.3% in children compared with 13.4% in adults. The association between age group and malaria positivity was statistically significant ($\chi^2 = 428.56$, $p < 0.001$).

***Corresponding Author:** Nazeer Mohammed Daffallah Hamid

Address: Faculty of Medical Laboratory Science, Alneelain University, Khartoum, Sudan.

Email ✉: safaahmedwdidi@gmail.com

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Conclusion: Malaria and dengue virus infections were detected at high frequencies in Shendi City during the study period, with an overwhelming predominance of *P. falciparum*. The substantial burden of dengue-malaria co-infection underscores the need for strengthened diagnostic capacity, enhanced laboratory surveillance, and integrated vector-control strategies. These findings highlight critical gaps in clinical recognition and laboratory confirmation of febrile illnesses in Sudan and emphasize the importance of dual testing during outbreak periods. **Keywords:** *Plasmodium falciparum*, dengue virus, co-infection, River Nile State, Sudan, outbreak epidemiology. **Method:** Data involved were collected from record of insurance clinics, as they were on registration protocols not like other medical clinics. 8 medical clinics' data was used for reflection of frequencies of malaria and dengue virus infection. **Result:** most of patients of this study were females, predominant of malaria parasite detected was *plasmodium falciparum* (99.5%). Malaria detected positive among 88.1% and negative among 11.9%, children with malaria were 300 (2.8%) and adults with malaria were 10276 (97.2%). Dengue virus was detected among 1952 (16.3%), children were 408 (20.9%) and adults were 1544 (79.1%). All dengue virus infected patients were already diagnosed having malaria. **Conclusion:** limited numbers of medical clinics were involved in this study due to lack of registration policies. Malaria and dengue were found in high frequencies and mostly PF.

INTRODUCTION

Climate variability and extreme weather events—driven by anthropogenic and natural changes in atmospheric greenhouse-gas concentrations—have further influenced the epidemiology of vector-borne diseases. Alterations in rainfall patterns, temperature, humidity, and ecological stability can modify mosquito breeding habitats, vector density, and pathogen transmission potential¹. Consequently, regions previously considered non-endemic may experience new or intensified transmission cycles. These environmental perturbations, combined with population displacement and infrastructure disruption, heighten the risk of simultaneous circulation of multiple vector-borne pathogens. The clinical overlap between malaria and dengue

fever presents a significant diagnostic challenge. Both conditions commonly manifest with acute febrile illness, headache, myalgia, arthralgia, gastrointestinal symptoms, and general malaise²⁻³. In resource-limited settings, reliance on clinical diagnosis alone frequently results in misclassification, delayed treatment, and inappropriate therapeutic interventions. Concomitant malaria–dengue infection may exacerbate disease severity and complicate clinical management, yet such co-infections are often under-recognized due to limited laboratory capacity⁴.

Clinicians in many Sudanese primary-care facilities continue to depend heavily on symptom-based diagnosis, despite the availability of hematological and serological assays capable of distinguishing between these infections. Recent observations from River Nile State, Sudan, indicate an apparent increase in febrile illnesses resembling malaria but demonstrating poor response to antimalarial therapy. Reports from Shendi City suggest a growing number of suspected dengue cases, raising concerns about concurrent transmission of both pathogens⁵.

The ongoing conflict in Sudan has further strained the healthcare system, disrupted diagnostic services, and facilitated population movement, potentially contributing to atypical transmission patterns and expansion of vector habitats. Given these emerging concerns, systematic investigation of malaria and dengue virus infections in Shendi City is urgently needed. Insurance-based medical clinics represent a unique source of structured clinical records, offering an opportunity to assess infection frequencies during the outbreak period. This study therefore aims to quantify the occurrence of malaria and dengue virus infections, characterize age-specific and species-specific distributions, and evaluate the extent of malaria–



dengue co-infection among patients attending eight insurance medical clinics in Shendi City, River Nile State. This work provides essential epidemiological evidence to support improved diagnostic strategies, strengthen surveillance systems, and inform integrated vector-control interventions in Sudan.

DIAGNOSIS OF MALARIA AND DENGUE VIRUS

MALARIA:

Recent advancements in malaria diagnosis technologies have been hindered in the great majority of malaria endemic areas by a number of factors, including the lack of laboratory infrastructure, operational costs, electricity requirements, and specialized operation expertise. This is particularly true for molecular testing, which can be quite costly in addition to additional difficulties with malaria and other infectious disorders. The principal method of detection, according to the WHO, is microscopy (both thin and thick film). Despite its widespread usage, microscopy cannot accurately identify low parasitemia, which is necessary for successful therapy and the eventual eradication of the parasitic infection. Additionally, it is a time-consuming procedure that calls for a great deal of knowledge and experience to make an appropriate diagnosis. The intrusive nature of this procedure, which requires a painful needle puncture to get blood samples, has also raised concerns because a correct diagnosis depends entirely on the laboratory scientist's judgment. There are higher risks of contamination and incorrect diagnosis since many developing nations lack the knowledge, tools, and resources needed for precise detection. Additionally, when transmissions decrease, it becomes more difficult and unreliable to identify low level infections; hence, different

methods of detection are required while elimination is being explored ⁶.

DENGUE VIRUS:

The detection of the virus, viral nucleic acid, antigens or antibodies, or a combination of these methods may be used in laboratory testing procedures to confirm dengue virus infection. The virus can be found in serum, plasma, circulating blood cells, and other tissues for four to five days following the commencement of disease. Virus isolation, nucleic acid analysis, or antigen detection can be employed to diagnose the infection in its early stages. Serology is the preferred diagnostic technique toward the conclusion of the acute phase of infection. High sensitivity and specificity tests typically call for more sophisticated technologies and technical know-how, whereas quick tests may sacrifice sensitivity and specificity in favor of speed and ease of use. Although virus isolation and nucleic acid detection are more expensive and labor-intensive than serologic antibody detection, they are also more specific ⁷.

OBJECTIVE OF THIS STUDY

to detect frequencies of malaria parasite infection and dengue fever in insurance clinics in Shendi City.

MATERIAL AND METHOD:

Study Design and Setting: This investigation employed a descriptive cross-sectional design to quantify the frequency of malaria and dengue virus infections among patients attending eight insurances-based medical clinics in Shendi City, River Nile State, Sudan. The study period extended from December 2025 to June 2026, corresponding to a documented increase in febrile illnesses in the region. Shendi City is situated



within the semi-arid ecological zone of northern Sudan, where malaria transmission is typically lower than in eastern and southern states. However, recent environmental disruption and population displacement have raised concerns regarding atypical transmission patterns of vector-borne diseases. The Study Population consisted of all patients who attended the participating insurance clinics during the defined study period. Insurance clinics were selected because they maintain structured registration systems, enabling consistent extraction of demographic and diagnostic data. Inclusion Criteria All patients registered at the eight clinics between December 2025 and June 2026. Patients for whom malaria or dengue diagnostic testing was performed. Exclusion Criteria Patients lacking diagnostic records for malaria or dengue. Patients with incomplete demographic information.

DATA COLLECTION PROCEDURES:

Clinical records were reviewed retrospectively. Extracted variables included: Age (categorized as children: 0–15 years; adults: >15 years), Sex, Malaria diagnostic results, Dengue diagnostic results, Type of malaria parasite detected, Diagnostic modality used, Data were entered into Microsoft Excel 2016 for cleaning and analysis.

DIAGNOSTIC METHODS:

Malaria Diagnosis Malaria infection was assessed using: Thick blood-film microscopy, the WHO-recommended gold standard for parasite detection. Immunochromatographic rapid diagnostic tests (RDTs) capable of detecting *Plasmodium falciparum* histidine-rich protein 2 (HRP2) and *P. vivax* lactate dehydrogenase (pLDH). Microscopy was performed by trained laboratory personnel using Giemsa-stained thick films. Parasite species identification was based on morphological characteristics. RDTs were used

when microscopy was unavailable or when rapid screening was required.

DENGUE VIRUS DIAGNOSIS:

Dengue virus infection was detected using immunochromatographic assays targeting: NS1 antigen (indicative of acute infection) IgM/IgG antibodies (indicative of recent or past exposure) These assays provide rapid point-of-care results but have variable sensitivity and specificity compared with molecular techniques such as RT-PCR. Outcome Measures Primary outcomes included: Frequency of malaria infection Frequency of dengue virus infection Distribution of malaria parasite species Frequency of malaria–dengue co-infection Age-specific infection rates Statistical Analysis Descriptive statistics were used to compute frequencies and proportions.

RESULT

A total of 12,000 patients attended the eight insurance-based medical clinics during the study period. Females constituted the overwhelming majority of the study population (11,728; 97.7%), whereas males represented only 272 patients (2.3%). Adults accounted for 11,492 patients (95.8%), while children represented 508 patients (4.2%). These demographic distributions reflect the healthcare-seeking patterns within insurance clinics rather than the general population structure of Shendi City. **Malaria Positivity:** Malaria infection was detected in 10,576 of 12,000 patients, corresponding to a positivity rate of 88.1%. A total of 1,424 patients (11.9%) tested negative. **Age-Specific Malaria Positivity** Children: 300 of 508 (59.1%) Adults: 10,276 of 11,492 (89.4%) Although adults represented the majority of malaria-positive cases numerically, age-specific analysis demonstrates that malaria positivity was significantly higher among adults.



The association between age group and malaria positivity was statistically significant ($\chi^2 = 428.56$, $df = 1$, $p < 0.001$), indicating a strong relationship between age and malaria infection risk.

Plasmodium Species Distribution Among malaria-positive patients, Plasmodium falciparum was overwhelmingly predominant: P. falciparum: 10,528 cases (99.5%) P. vivax: 48 cases (0.5%) This near-exclusive dominance of P. falciparum aligns with known transmission patterns in northern Sudan and underscores the clinical importance of P. falciparum in severe malaria outcomes.

Dengue Virus Positivity Dengue virus infection was detected in 1,952 of 12,000 patients, corresponding to a positivity rate of 16.3%.

Age-Specific Dengue Positivity Children: 408 of 508 (80.3%) Adults: 1,544 of 11,492 (13.4%) Although adults constituted the majority of dengue-positive patients numerically, children exhibited a markedly higher positivity rate. This pattern suggests increased susceptibility or exposure among pediatric patients during the outbreak period.

Malaria–Dengue Co-Infection All dengue-positive patients (1,952; 100%) were concurrently infected with malaria.

Co-infection therefore represented 19% of all malaria-positive cases.

Infection Distribution Malaria only: 8,324 patients (81%) Malaria + Dengue co-infection: 1,952 patients (19%) This high co-infection frequency highlights the diagnostic challenge posed by overlapping clinical presentations and underscores the need for dual diagnostic testing in febrile patients.

Summary of Key Findings Extremely high malaria positivity (88.1%) Near-exclusive dominance of P. falciparum (99.5%) Dengue positivity of 16.3% All dengue cases were co-infected with malaria Children exhibited disproportionately high dengue positivity (80.3%) Adults exhibited significantly higher malaria positivity (89.4%) Strong statistical

association between age and malaria positivity ($p < 0.001$)

DISCUSSION

The present study provides critical epidemiological evidence on the burden of malaria and dengue virus infections among patients attending eight insurance-based medical clinics in Shendi City, River Nile State, during a period of heightened febrile illness. The findings demonstrate exceptionally high malaria positivity (88.1%), substantial dengue virus detection (16.3%), and a notable malaria–dengue co-infection rate (19%). These results underscore the complex interplay of vector ecology, healthcare-seeking behavior, diagnostic capacity, and outbreak dynamics in northern Sudan.

Demographic Structure and Healthcare-Seeking Patterns. The study population was overwhelmingly female (97.7%) and predominantly adult (95.8%). This demographic skew likely reflects the characteristics of insurance-clinic utilization rather than true population distribution. Similar variability in sex-specific attendance has been documented in Sudanese healthcare settings, where clinic type, occupational patterns, and social roles influence patient flow. Therefore, demographic imbalances should be interpreted cautiously and not assumed to represent biological susceptibility.

Malaria Burden and Species Distribution. The malaria positivity rate of 88.1% is markedly higher than estimates reported in several Sudanese hospitals-based studies, where positivity typically ranges between 20% and 60%. This discrepancy may be attributed to: Concentration of clinically suspected cases in insurance clinics Seasonal transmission peaks Population displacement during conflict Limited diagnostic alternatives for febrile illness. The near-exclusive predominance of Plasmodium falciparum (99.5%) aligns with



established transmission patterns in northern and eastern Sudan, where *P. falciparum* remains the dominant species. However, this proportion exceeds reports from regions such as White Nile State⁸, where *P. vivax* contributes meaningfully to malaria burden. Such heterogeneity highlights the importance of species-specific surveillance for guiding treatment protocols and monitoring shifts in parasite ecology. Age-Specific Malaria Positivity. Although adults constituted the majority of malaria-positive patients numerically, age-specific analysis revealed significantly higher positivity among adults (89.4%) compared with children (59.1%). The strong statistical association ($\chi^2 = 428.56$, $p < 0.001$) suggests differential exposure patterns, possibly influenced by occupational activities, mobility, or clinic attendance behavior. These findings diverge from population-based studies in Sudan, where children often represent a substantial proportion of malaria cases. The contrast underscores the importance of distinguishing clinic-based infection frequency from community-level prevalence, as the two metrics capture different epidemiological realities. Dengue Virus Burden and Age Distribution. Dengue virus positivity (16.3%) in this study is comparable to findings from Kassala and other Sudanese regions², where dengue has increasingly emerged as a significant cause of febrile illness. The exceptionally high dengue positivity among children (80.3%) is noteworthy and suggests heightened susceptibility or exposure among pediatric populations during the outbreak period. This pattern contrasts with the numerical predominance of dengue-positive adults, which is attributable to the underlying population structure of the clinics. Age-specific positivity therefore provides a more accurate epidemiological interpretation than absolute case counts. Comparable findings have been reported in sub-Saharan African dengue studies, where children frequently exhibit higher seropositivity or

acute infection rates. These observations reinforce the need for pediatric-focused surveillance during dengue outbreaks¹⁰.

Malaria–Dengue Co-Infection: The detection of dengue virus exclusively among malaria-positive patients (100% co-infection) is a critical finding. Co-infection represented 19% of all malaria cases, substantially higher than co-infection rates reported in Kassala (6.6%) and Cameroon (approximately 10–20%). This elevated co-infection frequency may reflect: Overlapping transmission cycles High vector density Misdiagnosis of dengue as malaria Limited availability of dengue-specific diagnostics Clinically, malaria–dengue co-infection complicates diagnosis because both diseases share overlapping symptoms. Reliance on clinical diagnosis alone may lead to inappropriate treatment, delayed recognition of dengue complications, and increased morbidity. These findings highlight the urgent need for dual diagnostic algorithms in febrile-illness management in Sudan. Diagnostic Limitations and Implications. The diagnostic methods used—microscopy and immunochromatographic tests—are widely accessible but have inherent limitations. Microscopy may fail to detect low parasitemia, while rapid tests for dengue vary in sensitivity depending on the stage of infection. The absence of molecular confirmation (PCR) limits the ability to distinguish acute dengue infection from past exposure. Despite these limitations, the high positivity rates observed in this study strongly suggest intense concurrent transmission of malaria and dengue during the outbreak period. Comparison with Regional and Global Evidence. The findings align with emerging evidence that dengue is expanding into previously low-transmission regions of Sudan. Environmental disruption, climate variability, and population movement during conflict may have



facilitated the spread of *Aedes* vectors into River Nile State⁸. Similar patterns have been documented in other African countries experiencing ecological instability¹¹. The malaria burden observed in this study exceeds national averages reported in community-based surveys, reinforcing the distinction between clinic-based infection frequency and population prevalence. Insurance clinics may attract patients with more severe or persistent symptoms, thereby enriching the sample with malaria-suspected cases. Public Health Implications The substantial burden of malaria, dengue, and co-infection observed in this study underscores the need for: Strengthened laboratory capacity, Integrated vector-control programs. Enhanced clinician training in differential diagnosis, Routine dual testing for febrile illnesses, Continuous surveillance of malaria parasite species, Community-based epidemiological studies to complement clinic-based findings, these interventions are essential for mitigating morbidity and preventing misdiagnosis in regions experiencing overlapping transmission of malaria and dengue.

CONCLUSION

This study demonstrates a substantial burden of malaria and dengue virus infections among patients attending insurance-based medical clinics in Shendi City, River Nile State, during a period of intensified febrile illness. Malaria positivity was exceptionally high (88.1%), with an overwhelming predominance of *Plasmodium falciparum* (99.5%), reaffirming its central role in regional malaria epidemiology. Dengue virus infection was detected in 16.3% of patients, and all dengue-positive individuals were concurrently infected with malaria, resulting in a co-infection rate of 19%. Age-specific analysis revealed significantly higher malaria positivity among adults, whereas dengue positivity was

disproportionately elevated among children. These findings highlight the importance of interpreting clinic-based infection frequencies within the context of underlying population structures and healthcare-seeking patterns. The coexistence of malaria and dengue transmission in Shendi City underscores critical gaps in diagnostic capacity, particularly in settings where febrile illnesses are frequently managed based on clinical presentation alone. Strengthened laboratory infrastructure, implementation of dual diagnostic testing, and integrated vector-control strategies are essential to improve case detection, reduce misdiagnosis, and mitigate morbidity associated with overlapping vector-borne diseases. Given the dynamic ecological and epidemiological conditions in Sudan—exacerbated by conflict-related displacement and environmental disruption—continuous surveillance of malaria species distribution and dengue transmission patterns is urgently required. Future research should incorporate molecular diagnostic methods and community-based sampling to more accurately characterize transmission dynamics and inform public-health interventions

RECOMMENDATION

Infection control should be applied to involve causative agents, mosquitoes for malaria and dengue infections.

Wareness workshops should be applied in remote areas as lack of knowledge assists in disease spread.

Registration policies should be applied for all patients information as they are considered parts of national information.



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