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High seroprevalence of dengue virus infection among febrile patients in Kassala state, eastern Sudan: a cross-sectional analysis

Abstract

Background: Dengue fever (DF) is a mosquito-borne viral infection with rising global incidence, posing a significant public health challenge in many tropical regions, including Sudan. Kassala State has witnessed recurring outbreaks, underscoring the need for updated epidemiological data.

Objective: To assess the prevalence of recent dengue virus infection among febrile patients and explore demographic and clinical associations with seropositivity.

Methodology: A cross-sectional study was conducted from January to April 2025 in Kassala State. Febrile patients were enrolled, and 3 mL blood samples were collected 4–6 days after fever onset. Serum samples were tested for anti-DENV IgM using a commercial ELISA. Data were analyzed using SPSS version 28. **Results**: Among 93 patients tested, 83 (89.2%) were positive for DENV IgM and 10 (10.8%) were negative. The highest positive cases occurred in the 1–5 year age group (43.3% of seropositive cases). 47/93 (50.5%) were male and 46/93 (49.5%) were female. The majority (90.3%) reported symptom duration of 3–7 days. Urban residents comprised 74.2% of the patients, with no significant association between residence (urban vs. rural) and seropositivity (P = 0.23). Reported symptoms among IgM-positive patients included fever (100%), headache (89.2%), vomiting (52.7%), bleeding (16.1%), and convulsions (10.8%). There were no statistically significant associations between DENV IgM seropositivity and age group (P = 0.075), gender (P = 0.97), or duration of symptoms (P = 0.65).

Conclusion: A high rate of recent dengue infection was observed among febrile patients in Kassala State, indicating active transmission and the need for strengthened surveillance and control measures.

Keywords: dengue virus, IgM antibodies, ELISA, kassala, Sudan, febrile illness, arboviruses

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Introduction

Dengue fever (DF) is a mosquito-borne viral infection caused by the dengue virus (DENV), which thrives in tropical and subtropical regions that provide favorable conditions for vector breeding.[1] Humans are the primary carriers of the virus, and non-human primates play a significant role in the sylvatic cycle.[1,2] The dengue virus is primarily transmitted by the day-biting mosquito *Aedes aegypti*, a container breeder that thrives in urban environments.[3,4] The dengue virus (DENV) comprises four closely related serotypes (DENV 1–4).[5] Infection with DENV can result in a wide spectrum of clinical manifestations, ranging from severe forms—such as hemorrhagic fever and shock—to mild or asymptomatic cases, which are often overlooked, especially in children.[6,7] Dengue is currently endemic in more than 128 countries, placing nearly half of the world's population at risk. The global burden of dengue has surged significantly, with an estimated 390 million new infections each year, of which approximately 96 million present with clinical symptoms. This resurgence has been linked to several contributing factors, including rapid urbanization, increased international travel and trade, and inadequate vector control measures.[5,7] Infection with DENV has been described in Sudan as early as 1906 in the eastern part of the country,[8] with frequent epidemics confined to that region.[8-10] DENV outbreaks were later associated with Khartoum and the Northern state flooding in 1988 and 1989, respectively.[11,12] DENV has recently emerged in the southern and western regions of Sudan, causing large epidemics in refugee camps over the last 6 years. These recent epidemics of DENV have followed drastic changes in physical, social, and environmental factors as a result of the war and humanitarian crisis in these regions. As a result, DENV has become a serious public health issue in different areas of Sudan in recent years.[13,14] Sudan has faced recurrent dengue outbreaks over the past two decades. In 2005, an epidemic of dengue hemorrhagic fever was reported in Port Sudan, with a mortality rate of 3.8%. This outbreak, caused by DENV-3 (serotype 3), predominantly affected children and adolescents aged 5 to 15 years. Another major outbreak occurred in Port Sudan in 2010, resulting in 3,765 reported cases.[15] Between March 2016 and March 2017, dengue outbreaks were recorded in Kassala State, located in eastern Sudan near the Eritrean border, and later spread southwest to El-Gadaref State.[16] Additional outbreaks were documented in El Obeid, North Kordofan, during December 2012 and January 2017,[17] as well as in various states of the Darfur region in western Sudan.[18] Studies on the incidence of dengue virus (DENV) in Sudan have produced inconsistent findings, likely reflecting variations in geography, periods, and research methodologies.[19] Even in regions where DENV is endemic, shifts in circulating serotypes continue to occur, as demonstrated by the detection of DENV-2 in Kassala State in 2018.[20] The present study aims to assess the incidence of dengue infection among febrile patients in Kassala State, located in Eastern Sudan.

Materials and methods

A cross-sectional study examined the dengue virus (DENV) occurrence in Kassala State, Eastern Sudan. Dengue is classified as a reportable disease in Sudan, and surveillance officers gather essential demographic data and blood samples for confirmation. Participants were given a verbal explanation of the study and asked for consent to participate and provide blood specimens. One hundred participants completed a questionnaire detailing age, gender, clinical symptoms, and blood sample collection. The confidentiality of the data was preserved by storing records in a locked room with restricted access.

Study area

The current study was conducted in the eastern Sudanese state of Kassala. Kassala, the state's capital, spans an area of 36,710 km² and has an estimated population of approximately 1.8 million. Kassala State is situated in the semi-desert tropical zone, between latitudes 15.8058° N and longitudes 35.5658° E. The region experiences its highest rainfall between July and November, with an annual average precipitation of approximately 268 mm. The average annual temperature is around 29.2°C. Administratively, Kassala is divided into 11 localities: Kassala, Rural Kassala, West Kassala, New Halfa, Atbara River, Hamashkorieb, Elgirba, Delta North, Aroma, Talkuk, and Wad Elheiliew.

Study duration

The study was conducted from January 2025 to April 2025.

Study population

In this study, all patients with a fever were considered the population.

Study variables

The study's dependent variable was dengue patients, whereas the independent factors were gender, age, month of residency, and clinical symptoms (fever, headache, myalgia, arthralgia, skin rash, respiratory symptoms, gastrointestinal symptoms, and hemorrhagic signs).

Samples collection

Three milliliters of whole blood were typically collected between four to six days after the onset of fever. Samples were drawn using red-capped, sterile, disposable vacuum tubes without additives. The blood was left undisturbed at room temperature for 15 to 30 minutes to allow clotting, after which it was centrifuged at 2000 × g for 10 minutes. The resulting serum (supernatant) was carefully transferred into Eppendorf tubes using a Pasteur pipette. Samples were maintained at a temperature between 2°C and 8°C and stored at -20°C for up to seven days before analysis.

Analysis of specimens based on the ELISA method

Serum samples were tested using the Novagnost ELISA kit (GmbH, Germany). Briefly, 100 µL of diluted serum was added to 96-well plates pre-coated with dengue antigen and incubated at 37°C for 60 min. After washing, 100 µL of enzyme conjugate was added and incubated for 30 min. Following a second wash, 100 µL of substrate solution was added, and the reaction was stopped after 15 min. Optical density was measured at 450 nm.[21,22]

Statistical analysis

Data were analyzed using SPSS version 28. Descriptive statistics (frequencies and percentages) were calculated. Chi-square tests were used to determine associations between demographic/clinical factors and seropositivity. A *p-value* <0.05 was considered statistically significant.

Results

This cross-sectional analysis of 93 febrile patients in Kassala State, Eastern Sudan, revealed an exceptionally high seroprevalence of recent dengue virus infection. Anti-DENV IgM antibodies were detected in 89.2% (83/93) of participants, while only 10.8% (10/93) tested negative. The highest proportion of IgM-positive cases occurred among children aged 1–5 years (43.3%, 36/83), followed by the 6–11 year group (38.6%, 32/83). All adolescents aged 12–17 years (15/15) tested positive. The gender distribution was nearly equal among seropositive cases (50.6% male vs. 49.4% female), reflecting the overall cohort composition (50.5% male and 49.5% female). Most participants lived in urban areas (74.2%, 69/93), and 74.5% (61/83) of IgM-positive cases were urban residents. Symptom duration ranged from 3 to 7 days for 90.3% (84/93) of all patients, including 89.2% (74/83) of seropositive cases. Among IgM-positive individuals, all experienced fever, with common symptoms including headache (89.2%), vomiting (52.7%), bleeding (16.1%), and convulsions (10.8%). Statistical analysis showed no significant links between seropositivity and age group (*P-value* = 0.075), gender (*P-value* = 0.97), symptom duration (*P-value* = 0.65), or urban/rural residence (*P-value* = 0.23) (Tables 1 & 2).

Table 1 Demographic characteristics and seropositivity of study participants

Characteristic	Category	Total n (%)	IgM+ n (%)	IgM- n (%)
Age group	1–5 years	44 (47.3%)	36 (81.8%)	8 (18.2%)
	6–11 years	34 (36.6%)	32 (94.1%)	2 (5.9%)
	12–17 years	15 (16.1%)	15 (100%)	0 (0%)
Gender	Male	47 (50.5%)	42 (89.4%)	5 (10.6%)
	Female	46 (49.5%)	41 (89.1%)	5 (10.9%)
Residence	Urban	69 (74.2%)	61 (88.4%)	8 (11.6%)
	Rural	24 (25.8%)	22 (91.7%)	2 (8.3%)
Symptom duration	3–7 days	84 (90.3%)	74 (88.1%)	10 (11.9%)
	>7 days	9 (9.7%)	9 (100%)	0 (0%)

Table 2 Symptoms among IgM-positive patients

Symptom	No (%)
Fever	83 (100%)
Headache	74 (89.2%)
Vomiting	44 (52.7%)
Bleeding	13 (16.1%)
Convulsions	9 (10.8%)

Discussion

This study shows a remarkably high seroprevalence (89.2%) of recent dengue virus infection among febrile patients in Kassala State. The dominance among children, especially those aged 1–5 years, emphasizes a vulnerable group that needs targeted intervention. Dengue fever, caused by dengue virus (DENV), has become one of the most important mosquito-borne viral diseases with a steady rise in global incidence, including Sudan.[23] Furthermore, other African nations that border Sudan, such as South Sudan, Ethiopia, Eritrea, Uganda, Kenya, the Democratic Republic of the Congo, Egypt, and Libya, have also recorded cases of dengue.[24] The eastern Sudanese cities of Kassala and Port Sudan had a dengue outbreak in 2019. The two locations' vector control procedures have been interrupted in prior years. A dengue virus infection was suspected after a sharp rise in passively reported fever cases among the two cities' inhabitants. Since malaria is widespread in the area, the suspected patients were first examined for the disease using the national procedure for diagnosing fever.[25] Regardless of the diagnosis's outcome, several patients received treatment for malaria before participating in our trial. These choices are typical and show how unreliable the diagnosis of malaria is. Dengue fever was suspected based on prior dengue epidemics in the two cities. According to recent reports, DENV is a significant new infectious viral disease in Sudan. Several outbreaks and isolated DF cases have been regularly documented in eastern Sudan.[26] Little information is available on the actual illness burden and economic effects of DENV because most African countries lack quick and accurate diagnosis and thorough study of outbreaks.[27] Very little is known about the circulating serotypes and related genotypes in Sudan. Most disease epidemiology studies are based on serological surveys.[28] Also, dengue fever has been a prevalent pandemic in eastern Sudan since the early 1900s.,[29] with outbreaks occurring regularly.[30] Although yellow fever outbreaks have recently occurred in Darfur,[31] DENV was only found in a small number of individuals in 2014 in Al-Fashir, the capital of North Darfur. Urbanization has spread throughout Sudan due to the rapid growth of new cities around the Red Sea and the Nile River. The spread of DENV has been greatly aided by urbanization, climate change, and increased human mobility.[32] According to reports, the prevalence rates of DENV seropositivity in western Sudan's Kordofan and Darfur States were 27.7% and 15.7%, respectively.[33] Interestingly, the current study found that individuals of Kassala State had a high prevalence of IgM antibodies of recent DENV infection, indicating that DENV has recently spread during the study period. Globally, dengue fever is becoming a more serious health issue.[34] Numerous regions of Sudan have seen recurrent dengue outbreaks. Based on clinical symptoms and serological testing, earlier publications on dengue in Sudan detailed isolated outbreaks. Fever, abdominal discomfort, joint pain, and vomiting were the most common clinical symptoms, consistent with findings from earlier research on dengue outbreaks in eastern Sudan. In earlier studies of dengue patients, the participants' laboratory tests were characterized by leukopenia and pancytopenia.[35] Identifying the dengue NS1 antigen and anti-dengue IgM antibodies served as confirmation of dengue infection. Malaria had been suspected first, delaying confirmation. Patients who had a fever for less than four days and tested positive for the dengue NS1 antigen were found to have an early infection. Since all IgM-positive patients tested positive for NS1 antigen, it was clear that NS1 antigen detection had a higher sensitivity than anti-dengue IgM ELISA. There have been earlier reports of similar results.[36] Since Chikungunya and Rift Valley virus infections have been documented from the two research sites in the past, the samples that tested negative in anti-dengue IgM serology and NS1 antigen tests need to be examined further for infection by other arboviruses.[37] In addition to offering priceless insight into arbovirus research, these investigations will produce data essential for creating effective public health policies for preventing and managing dengue illnesses.[38] More data and information may have been included in this review, which would have provided deeper insights into the spread of DENV in Sudan. However, the absence of international and local funding for Sudan's research and control efforts on arboviral illnesses and the health authorities' failure to share real-time data and information concerning health emergencies are the causes of these restrictions.[39] The lack of statistically significant links with demographic variables indicates widespread transmission across all subpopulations. This is consistent with findings from previous outbreaks in Kassala and Port Sudan and is probably worsened by insufficient vector control, urban expansion, and limited health infrastructure. Similar patterns have been seen in other African regions where environmental and socioeconomic factors play a role in arboviral transmission. The absence of NS1 antigen testing in this study hampers early detection and highlights the need for comprehensive diagnostic algorithms.

Conclusion

This investigation confirms a high burden of dengue infection among febrile patients in Kassala State during the study period. The findings emphasize the urgent need for enhanced public health strategies, including improved diagnostic capabilities, routine surveillance, and robust vector control programs.

Recommendations

Effective dengue control requires integrating DENV testing into routine febrile illness assessments in endemic areas, enhancing public awareness, strengthening laboratory diagnostics, promoting community-led vector control, and implementing policy reforms to classify dengue as a nationally reportable disease with region-specific response plans.

Consent

The patient's written consent has been collected.

Ethical approval

The study was approved by the Department of Medical Microbiology in Medical Laboratory Sciences at Shendi University; the study was matched to the ethical review committee board. Sample collection was done after signing a written agreement with the participants. Permission for this study was obtained from the local authorities in the area. This study's aims and benefits were explained with the assurance of confidentiality. All protocols in this study were done according to the Declaration of Helsinki (1964).

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Conflicts of interest

The authors have declare that no conflicts of interests.

References

1. Weaver SC, Reisen WK. Present and future arboviral threats. *Antiviral Res*. 2010;85(2):328–345.
2. Endy TP, Anderson KB, Nisalak A, et al. Determinants of inapparent and symptomatic dengue infection in a prospective study of primary school children in Kamphaeng Phet, Thailand. *PLoS Negl Trop Dis*. 2011;5(3):e975.
3. Gubler DJ. Dengue, urbanization, and globalization: the unholy trinity of the 21st century. *Trop Med Health*. 2011;39(4 Suppl):S3–S11.
4. Ngugi HN, Mutuku FM, Ndenga BA, et al. Characterization and productivity profiles of *Aedes aegypti* (L.) breeding habitats across rural and urban landscapes in western and coastal Kenya. *Parasites Vectors*. 2017;10(1):331.
5. Bhatt S, Gething PW, Brady OJ, et al. The global distribution and burden of dengue. *Nature*. 2013;496(7446):504–507.

6. Vu DM, Mutai N, Heath CJ, et al. Unrecognized dengue virus infections in children, western Kenya, 2014–2015. *Emerg Infect Dis*. 2017;23(11):1915–1917.
7. Simmons CP, Farrar JJ, van Vinh Chau N, Wills B. Dengue. *N Engl J Med*. 2012;366(15):1423–1432.
8. Saigh S. Dengue in Port Sudan, Red Sea Province. *J Trop Med Hyg*. 1906;9:348.
9. Gindeel NJH. Sero investigation of dengue fever epidemic in Port Sudan and molecular typing of the virus [master's thesis]. Khartoum, Sudan: University of Khartoum; 2015.
10. Malik A, Earhart K, Mohareb E, et al. Dengue hemorrhagic fever outbreak in children in Port Sudan. *J Infect Public Health*. 2011;4(1):1–6.
11. McCarthy MC, Haberberger RL, Salib AW, et al. Evaluation of arthropod–borne viruses and other infectious disease pathogens as the causes of febrile illnesses in the Khartoum Province of Sudan. *J Med Virol*. 1996;48(2):141–146.
12. Watts DM, Tigani A, Botros BA, et al. Arthropod–borne viral infections associated with a fever outbreak in the northern province of Sudan. *J Trop Med Hyg*. 1994;97(4):228–230.
13. Ahmed A, Elduma A, Magboul B, et al. The first outbreak of dengue fever in Greater Darfur, western Sudan. *Trop Med Infect Dis*. 2019;4(1):43.
14. Ahmed A, Ali Y, Elmagboul B, et al. Dengue fever in the Darfur area, western Sudan. *Emerg Infect Dis*. 2019;25(11):2120–2123.
15. Seidahmed OM, Siam HA, Soghaier MA, et al. Dengue vector control and surveillance during a major outbreak in a coastal Red Sea area in Sudan. *East Mediterr Health J*. 2012;18(12):1217–1224.
16. Elaagip A, Alsedig K, Altahir O, et al. Seroprevalence and associated risk factors of dengue fever in Kassala state, eastern Sudan. *PLoS Negl Trop Dis*. 2020;14(12):e0008918.
17. Adam A, Schüttoff T, Reiche S, Jassoy C. High seroprevalence of dengue virus indicates that infections are frequent in central and eastern Sudan. *Trop Med Int Health*. 2018;23(9):960–967.
18. Ahmed A, Eldigail M, Elduma A, et al. First report of epidemic dengue fever and malaria co–infections among internally displaced persons in humanitarian camps of North Darfur, Sudan. *Int J Infect Dis*. 2021;108:513–516.
19. Ahmed A, Dietrich I, LaBeaud AD, et al. Risks and challenges of arboviral diseases in Sudan: the urgent need for actions. *Viruses*. 2020;12(1):81.
20. Hamid Z, Hamid T, Alsedig K, et al. Molecular investigation of dengue virus serotype 2 circulation in Kassala State, Sudan. *Jpn J Infect Dis*. 2019;72(1):58–61.
21. Innis BL, Nisalak A, Nimmannitya S, et al. An enzyme–linked immunosorbent assay to characterize dengue infections where dengue and Japanese encephalitis co–circulate. *Am J Trop Med Hyg*. 1989;40(4):418–427.
22. Figueiredo L, Simões M, Cavalcante S. Enzyme immunoassay for detecting dengue IgG and IgM antibodies using infected mosquito cells as antigen. *Trans R Soc Trop Med Hyg*. 1989;83(5):702–707.
23. Eldigail MH, Adam GK, Babiker RA, et al. Prevalence of dengue fever virus antibodies and associated risk factors among residents of El–Gadarif state, Sudan. *BMC Public Health*. 2018;18(1):921.
24. Van Kleef E, Bambrick H, Hales S. The geographic distribution of dengue fever and the potential influence of global climate change. *ISEE Conference Abstracts*. 2010.
25. Abdallah TM, Ali AA, Karsany MS, Adam I. Epidemiology of dengue infections in Kassala, Eastern Sudan. *J Med Virol*. 2012;84(3):500–503.
26. Eldigail MH, Abubaker HA, Khalid FA, et al. Association of genotype III of dengue virus serotype 3 with disease outbreak in Eastern Sudan, 2019. *Virol J*. 2020;17(1):118.
27. Konongoi L, Ofula V, Nyunja A, et al. Detection of dengue virus serotypes 1, 2, and 3 in selected regions of Kenya: 2011–2014. *Virol J*. 2016;13(1):182.
28. Soghaier MA, Himatt S, Osman KE, et al. Cross–sectional community–based study of the socio–demographic factors associated with the prevalence of dengue in the eastern part of Sudan in 2011. *BMC Public Health*. 2015;15:558.
29. Seidahmed OM, Hassan SA, Soghaier MA, et al. Spatial and temporal patterns of dengue transmission along a Red Sea coastline: a longitudinal entomological and serological survey in Port Sudan city. *PLoS Negl Trop Dis*. 2012;6(9):e1821.
30. Balfour A, Archibald RG. Review of some of the recent advances in tropical medicine, hygiene and tropical veterinary science. Khartoum: Sudan government, department of education. 1908.
31. Markoff L. Yellow fever outbreak in Sudan. *N Engl J Med*. 2013;368(8):689–691.
32. Brady OJ, Gething PW, Bhatt S, et al. Refining the global spatial limits of dengue virus transmission by evidence–based consensus. *PLoS Negl Trop Dis*. 2012;6(8):e1760.
33. Wilder–Smith A, Gubler DJ. Geographic expansion of dengue: the impact of international travel. *Med Clin North Am*. 2008;92(6):1377–1390.
34. Were F. The dengue situation in Africa. *Paediatr Int Child Health*. 2012;32(S1):18–21.
35. Abdallah TM, Ali AA, Karsany MS, Adam I. Epidemiology of dengue infections in Kassala, Eastern Sudan. *J Med Virol*. 2012;84(3):500–503.
36. Arya SC, Agarwal N, Parikh SC. Detection of dengue NS1 antigen, alongside IgM plus IgG, and concurrent platelet enumeration during an outbreak. *Asian Pac J Trop Med*. 2011;4(8):672.
37. Adam A, Seidahmed OM, Weber C, et al. Low seroprevalence indicates vulnerability of eastern and central Sudan to infection with chikungunya virus. *Vector Borne Zoonotic Dis*. 2016;16(4):290–291.
38. Ahmed A, Dietrich I, LaBeaud AD, et al. Risks and challenges of arboviral diseases in Sudan: the urgent need for actions. *Viruses*. 2020;12(1):81.
39. Ahmed A. Urgent call for a global enforcement of the public sharing of health emergencies data: lessons learned from serious arboviral disease epidemics in Sudan. *Int Health*. 2020;12(4):238–240.