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Dengue Virus and Malaria Parasitemia in Africa: A Narrative Review

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Abstract - Dengue virus infection and malaria parasitaemia are significant mosquito-borne diseases in Africa, especially in Nigeria. This review highlights their epidemiology, transmission, diagnosis, and public health impact, with emphasis on their similar early clinical features, which often result in misdiagnosis. Dengue, caused by Flavivirus serotypes, is increasingly prevalent and lacks a specific cure, while malaria, mainly due to Plasmodium falciparum, remains highly endemic but treatable. The occurrence of dengue–malaria co-infection further complicates diagnosis and management. Laboratory methods such as microscopy, serology, and RT-PCR are essential for accurate detection. Effective control relies on vector management, early diagnosis, and improved public health strategies.

Keywords: Dengue virus; Malaria; Co-infection; Diagnosis; Nigeria; Vector control

I. INTRODUCTION

Dengue virus infection is a mosquito-borne viral disease that has rapidly spread around the globe (WHO, 2021). Dengue is considered one of the most dangerous mosquito-borne viral diseases (ECDC, 2025). It is spread by different species of female mosquitoes of the *Aedes* genus, mainly *Aedes aegypti*. These mosquitoes are also vectors of chikungunya, yellow fever and Zika viruses (Rajesh, 2016). Dengue is widespread throughout tropic and subtropical areas, it affects urban and semi-urban settlements (Liu, 2021).

Dengue virus (DENV) infection is caused by one of the Four serotypes of the virus (DENV-1, DENV-2, DENV-3, and DENV-4) belonging to the genus Flavivirus of the *Flaviviridae* family (WHO, 2022).

While most people recover from dengue after 5-7 days of illness, 1 out of 20 cases will result to severe dengue. Anyone formerly infected is also at risk of having severe (CDC, 2021). In severe dengue the blood vessels become damaged and begin to leak, the number of platelets drop, leading to tissue damage, organ impairment, internal bleeding and possibly death (Rathore *et al,* 2019).

Malaria is also a mosquito-borne disease caused by the plasmodium parasite, transmitted by female *Anopheles* mosquitoes. Five species of plasmodium cause malaria in humans. Namely; *Plasmodium falciparium, Plasmodium vivax, Plasmodium malariae, Plasmodium ovale* and *Plasmodium knowlesi. Plasmodium falciparium* is the deadliest of the 5 species, it is responsible for one-third of malaria deaths (WHO, 2024).

Malaria is a global health problem, with about 214 million cases yearly and 3.2 billion people are at risk of infection (Katnap *et al* 2020). In Nigeria, *P. falciparum* accounts for more than 95% of malaria infection, while *P. malariae* and *P. ovale* are estimated to be responsible for less than 5% of infection (Oriero, 2020).

Dengue virus and malaria parasitemia are both febrile mosquito-borne diseases with similarities in the early stages of the diseases (katnap *et al, 2020*). Dengue fever is the most important and rapidly spreading mosquito-borne viral disease in the world but it doesn't have a cure. Malaria on the other hand is curable but its control is a nagging problem in most African countries. Febrile patients should be tested for both diseases because of their similarities, as they both pose serious threats to public health.

II. HISTORY OVERVIEW OF DENGUE VIRUS

In Africa, cases of dengue were first recorded in 1779 (Emily *et al* 2022). DENV-1 was the first serotype to be isolated, this was in south Africa in 1927, after this, cases of dengue virus in other African countries were also recorded including Nigeria in 1964.

Dengue virus poses a risk to 2.5–3.6 billion people yearly, in over 125 endemic countries (Otu *et al*, 2019), it has an estimated incidence of about 390 million cases per year and 2 million cases generate dengue hemorrhagic fever with 20,000 resulting to death (*Katnap et al, 2020*). In 2024, the World Health Organization (WHO) reported over 7.6 million

dengue cases by April 30, with more than 3,000 deaths. This marked a substantial increase compared to previous years, particularly in the Americas, where cases exceeded seven million by that date, surpassing the annual high of 4.6 million cases in 2023 (WHO, 2024). By July 23, 2024, the number of reported cases had risen to over 10 million across 176 countries, making it the worst year for dengue on record (Lancet, 2024).

The African region experienced a significant burden, with 208,289 suspected cases, of which 95,922 were confirmed or considered probable. By January 14, 2024, 782 deaths had been reported across 15 African countries including Nigeria (WHO, 2024). Burkina Faso was the hardest-hit nation, accounting for 75% of the reported cases and 91% of the fatalities in the region (WHO, 2024). Dengue virus infection is also a growing public health problem in Nigeria. To accentuate the magnitude of dengue in Nigeria, recent seroprevalence surveys conducted in Maiduguri (Northern Nigeria) and in Ilorin (Western Nigeria) showed that 10.1% and 30.8% of participants respectively, were seropositive for dengue subtype-3 virus (DENV-3) (Otu *et al*, 2019) (Idris *et al,* 2013). Additionally, dengue IgM sero-prevalence among febrile Nigerian children in South-Western Nigeria has been reported to be between 17.2% and 30.8% (Otu *et al*, 2019), and also the prevalence of 17.4% in Plateau state (North-central Nigeria) (Katnap *et al.* 2024). These high prevalence figures of symptomatic dengue virus infections and dengue IgM antibodies indicate the potential endemicity of dengue and the validity of its misdiagnosis by frontline health workers. This is also indicative of high vector density in highly populated Nigerian cities.

In a study conducted by (Emeribe *et al,2021*) using geopolitical regions, the seroprevalence of DENV IgG was greatest in South-east Nigeria (77.1%), seconded by North-west (37.6%), South-west (34.3%), North-central (23.5%), and least in South-southern Nigeria (3.9%). The diagnosis of dengue in Nigeria is further complicated by evidence of high co-infection rates of malaria and dengue, as well as its similarity with malaria in the early stage of the infection (Salam *et al.*, 2018). There were also reports of dengue and malaria co-infection in the northern part of Nigeria (Baba, 2009) and north central (Katnap *et al*., 2024). Then, severe dengue in Nassarawa state of north central Nigeria and Kaduna state of North West, Nigeria, in 2014 (Kenneth *et al.,*2018).). Also, cases of malaria parasitemia and dengue virus infection co-infection have been recorded in southwestern Nigeria (Okoror, 2021).

III. PATHOGENESIS OF DENGUE VIRUS

Infection with any of the four DENV serotypes, results in dengue fever infection. The major viral envelope (E) of glycoprotein in the virus helps to bind the host cells, then the virus replicates itself, monocytes are the primary target, infected monocytes induce the production of interferon-a (IFN-a) and IFN-b . Envelope (E), precursor membrane protein (pre-M), and nonstructural protein 1 (NS1) are the major DENV proteins targeted by antibodies as part of the host immune response. Studies have shown that DENV-specific CD4+ and CD8+ T lymphocytes attack infected cells and release IFN-g, tumor necrosis factor-a (TNF-a), and lymphotoxin (Ramalingam *et al* 2020) resulting to a disease. After recovery, the system becomes responsible for the infection, but this also, increases susceptibility to other serotypes and increases the chances of the disease to generate to dengue haemorrhagic fever (Bhatt *et al.*, 2020)

Severe dengue mainly affects patients with secondary DENV infections and infants with primary infections. The leading hypothesis for its pathogenesis is antibody-dependent enhancement (ADE), where nonneutralizing antibodies help the virus infect more cells, increasing viral production. Normally, antibodies protect against viruses through neutralization, opsonization, and antibody-dependent cellular cytotoxicity (ADCC). However, in dengue, pre-existing heterotypic IgG antibodies from a prior infection (or passively acquired in infants) can form complexes with the virus, facilitating its entry into macrophages, where it replicates and amplifies infection (CDC 2018).

IV. TRANSMISSION

Dengue virus is transmitted by mosquitoes of the genus *aedes*, mainly *aedes aegypti* and also *aedes albopictus* (WHO, 2024). *Aedes aegypti* is a vector of several viruses, including Zika virus, yellow fever, chinkungunya (ECDC, 2025). These mosquitoes thrive in tropical, subtropical and some temperate regions but *aedes albopictus* can survive in cooler regions (CDC, 2020). Adult mosquitoes of the *aedes*

genus can be recognized by their typically black bodies, dark scales on the abdomen and thorax, and alternating light and dark bands on the legs (Kara, 2016). These mosquitoes usually bites in the early hours of morning, and in the evening. A female *aedes* mosquito bites an infected person, and becomes infected in its midgut and the diseases spreads all over body cavity, and tissues including the salivary gland and becomes infected, after an extrinsic incubation of 8-12 days, the mosquito can spread dengue (CDC,2018)

Dengue virus and malaria can also be transmitted intrapartum, from an infected mother, to an unborn child during pregnancy, labour or breastfeeding (Vindika *et al* 2014)

Transmission through infected blood during blood transmission, organ transplant, bone marrow, infected needles or syringes (Chen *et al* 2004). Although it is extremely rare , sexual transmission of dengue has been recorded (Wilder, 2019)

V. SIGNS AND SYMPTOMS OF DENGUE VIRUS

Dengue is also known as break-bone fever, because of the intensity of the muscle spasms caused by this illness (Timothy, 2022). Its most common symptoms are; Nausea, Head aches, Fever, Rash, Joint pain. The self-limiting illness, lasts about 2-7 days, but can become severe and generate into dengue haemorrhagic fever or dengue shock syndrome 24-48 hours after recovery (CDC, 2021), characterized by low platelet count, internal bleeding, shock and death.

VI. DIAGNOSIS

Clinical diagnosis of dengue is unreliable because the early symptoms of dengue resemble that of malaria and can therefore be misdiagnosed as malaria (Katnap *et al,* 2020)

Laboratory diagnosis can be done in different ways;

1. Virus Isolation
   Virus isolation is typically performed within 5 days of infection onset using serum, plasma, or peripheral blood mononuclear cells such as lymphocytes and macrophages. Mosquito cell lines, particularly C6/36 (derived from *Aedes albopictus*) and AP61 (*Aedes pseudoscutellaris*), are commonly used for routine dengue virus isolation. However, since many wild-type dengue viruses do not produce visible cytopathic effects in these cells, detection requires confirmation using antigen detection immunofluorescence assays with serotype-specific and flavivirus-reactive monoclonal antibodies. Although mammalian cell lines such as Vero, LLCMK2, and BHK21 may also be used, they are generally less effective. Virus isolation followed by immunofluorescence is highly confirmatory but may take 1–2 weeks and depends on proper specimen handling, as the dengue virus is heat labile (WHO, 2009; David et al., 2017).

2. Reverse Transcription-
   Polymerase Chain Reaction (RT-PCR)
   RT-PCR is a widely used and sensitive method for dengue virus detection. It involves the conversion of viral RNA into complementary DNA followed by amplification of specific viral gene segments, enabling both detection and serotype differentiation. The CDC DENV-1–4 real-time RT-PCR multiplex assay is commonly used for detecting dengue virus serotypes 1–4 in serum or plasma from suspected cases. This assay includes oligonucleotide primers and TaqMan® probes, a positive control virus mix (heat-inactivated DENV-1 to DENV-4 strains), and a human specimen control to ensure RNA integrity and successful extraction. The assay can be performed in singleplex or multiplex formats, both offering comparable sensitivity (CDC, 2023).
3. Serology tests;
   Several serology tests are available for the detection of dengue virus for example. Plaque reduction neutralizing tests (PRNT), Hemagglutination inhibition (HI), ELISAs for the detection of IgM and IgG antibodies

VII. PREVENTION AND CONTROL

Vector control

The control of arthropod borne diseases lies mainly in the control of the vectors. The use of mosquito repellents containing; DEET, picaridin or lemon eucalyptus oil on exposed skin and also wearing of protective clothing. The use of insecticides to kill mosquitoes and the use of biological methods to target the larval stage of the mosquito in water

bodies. Also, eliminate mosquito breeding sites such as tires uncovered water containers, or any form of stagnant water (CDC, 2023).

Early detection

Early detection and management of dengue virus is important since it has no cure. It is advised to seek medical attention and running of tests is advised for patients with fever, severe head ache and joint pains which are symptoms of dengue virus infection (Nguyen *et al*, 2015).

Vaccines

Vaccines for the prevention of dengue virus exists, this vaccine is used to prevent a reoccurrence of dengue virus in people who have previously had the disease. It is recommended for children from 9-6 years. It is in 3 doses and should be administered at 6months interval.

VIII. TREATMENT

There is no cure for dengue but it can be managed by adequate intake of fluids and by use of pain relief Acetamophin or paracetamol. (CDC, 2023; Darvin, 2022).

IX. OVERVIEW OF MALARIA PARASITEMIA

Malaria has earned a special spot in history, as it has been been a source of suffering and death since the 1300s (Arrow *et al* 2004). Malaria is said to have originated from Africa, humans are said to have gotten malaria from gorillas, chimpanzees and other non-primates (Hempelmann, 2010). Malaria had gone by different names “intermittent fever,” “marsh fever,” “agues,” “quartan fevers” before the name malaria was formed (Hempelmann *et al*, 2013). Malaria, meaning “bad air” is a life-threatening disease that occurs primarily in tropical and subtropical areas of the world. It is caused by *plasmodium species* (CDC, 2021). The cause of malaria was unknown until Ronal Ross (1897) discovered that mosquitoes were the carriers of malaria (Hempelmann *et al*,2013). since then, control measures have been put up to curb, control and eliminate mosquitoes as well as malaria, but all efforts have proven nonfutile.

Although malaria drugs have been developed since the 19th century, malaria was the cause of death of over 896,000 people in 2000 (Max, 2015). Although malaria deaths were cut by 36% from 2010 to 2020, in 2020 there were 241 million cases of malaria and 627,000 deaths 95% occurring in Africa (CDC, 2021). Africa still bore the grievous burden in 2021, there were 247 million cases of malaria globally, 234 million of cases occurred in Africa and 593,000 deaths in Africa (WHO, 2022). Still in 2021, 470,000 innocent children lost their lives to malaria, accounting for 77% of the global malaria death (UNICEF, 2023).

Nigeria bears the world’s greatest burden of malaria (31.3%) (WHO, 2023) 207 million cases and 207,000 deaths yearly (Salwa *et al* 2016). Nigeria is endemic, with 97% of its population at risk of malaria and only 3% live in malaria free zones (Okeke, 2012). Malaria is also responsible for the death of about 95,000 children in Nigeria (Dagupta *et al* 2022) and about 11% maternal deaths are related to malaria

Malaria is one of the most important public health problems worldwide. Although it has a cure, malaria remains a major problem in the world, with over 263 million cases in and nearly 600,000 deaths (WHO, 2024). According to the latest World Malaria report, there were 241 million cases of malaria in 2020 compared to 227 million cases in 2019. The estimated number of malaria deaths stood at 627 000 in 2020 – an increase of 69,000 deaths over the previous year (WHO, 2021) . The incidence of malaria in 2023 surpassed that of 2022 by 11 million (WHO, 2024)

In 2024, WHO regions in African countries accounted for 94% of all malaria cases and 95% of malaria deaths. Nigeria bears 21% of the global malaria burden and 30% of global deaths (WHO, 2024). In Nigeria, it is a leading cause of death and sickness and accounts for 20% of mortalities (Raymond, 2020). Among the major reasons for the increase in malaria disease is the presence of drug-resistant species of the vector mosquito, the preponderance of enabling environments such as poor living conditions, and the inadequacy of primary health infrastructure to treat the disease (Onah *et al.*, 2017). Malaria is a disease of poverty, suffering, and death.

X. PATHOGENESIS OF MALARIA

Malaria is transmitted by anopheles female mosquitoes. The gametophyte form of plasmodium is

acquired from the blood of an infected person, the parasites migrates to the mid gut mates and multiplies after 18-20 days a sporozoite is formed, the sporozoite formed then migrates to the salivary gland (CDC, 2020). The infected mosquito bites a human or animal, the sporozite is inoculated into the blood stream alongside saliva. The sporozoites, infect liver cells (hepatocyte) and mature into schizonts from which merozoite cells are released (NIH, 2013). This stage is asymptomatic.

The merozoite, exit the liver and enter the blood stream, it attacks the red blood cells, within red blood cells, the parasites digest hemoglobin. As hemoglobin is digested, the pigment hemozoin and the toxin glycophosphatidylinositol, is released, at this stage malaria symptoms begin. The merozoite, develop into gametocyte which are ingested by mosquitoes and the cycle begins again (Mawson, 2013).

XI. TRANSMISSION

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Malaria is primarily spread by female mosquitoes of genus *Anopheles*. There are over 400 species in this genus but only about 40 of them transmit malaria, These different species spread malaria in different region worldwide except Antarctica (CDC, 2020). They are dark to brown in color, long and slender.

Malaria can also be spread through other ways since malaria parasite resides in the blood stream, it can be transmitted through blood transfusion, organ transfer or use of contaminated needles or syringes (CDC,2022). Can also be transmitted from mother to child, through the placenta (trans-placental malaria).

XII. DIAGNOSIS

The laboratory diagnosis of malaria involves several methods to detect the presence of the malaria parasite or antigens in patient's blood, there are different techniques for this; (Noppadon, 2009).

1. Microscopic examination of blood smears: This is considered the gold standard for malaria diagnosis. A drop of the patient's blood is spread on a glass slide, stained, and examined under a microscope to identify and quantify malaria parasites (CDC,2018)
2. Rapid diagnostic tests (RDTs): These are simple, rapid, and easy-to-use tests that detect specific malaria antigens in the patient's blood. RDTs provide quick results and do not require extensive laboratory equipment.
3. Polymerase Chain Reaction (PCR): PCR is a highly sensitive molecular technique that amplifies and detects the genetic material (DNA or RNA) of the malaria parasite. It can identify low levels of parasites and determine the species of malaria involved.
4. Serological tests: Serological tests detect specific antibodies produced

XIII. PREVENTION AND CONTROL

Malaria can be prevented by vector control just like dengue fever. Sleeping under insecticide treated nets as well removing breeding sites for mosquitoes are important ways to prevent malaria. Early detection of malaria would lead to early treatment, therefore it is also a way to control malaria (WHO, 2022).

XIV. TREATMENT

Malaria is treated based on the specie of malaria isolated. Chloroquine or hydroxychloroquine can be used to cure malaria, except malaria caused by *Plasmodium falciparum* (CDC, 2023) Artemisinin-based combination therapies (ACTs) is the most effective treatment for malaria caused by *plasmodium falciparum.* Artemisinin is used to reduce the number of parasites and the other component of the drug is used to eliminate what is left of the organisms (WHO, 2023).

XV. CONCLUSION

Dengue is an important neglected disease of the tropical and subtropical regions today. It is a complex disease whose symptoms are difficult to distinguish from other common febrile illnesses like malaria and can progress from a mild, non-specific viral disease to irreversible shock and death within a few hours. Early detection of the virus is of utmost relevance because it allows early clinical management, but the fact that this virus possesses the same early symptoms as malaria parasitaemia makes clinical diagnosis difficult (WHO, 2009). In recent times, dengue virus has become more prevalent and life threatening and should be taken more seriously.

Malaria remains a disease of poverty, suffering and death and precautionary measures should be taken, such as the use of mosquito-treated nets, clean environments free from stagnant water, and frequent use of insectides to prevent this disease.

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