

**Original Article****Open Access****Detection of Dengue IgM and IgG among apparently healthy and sick individuals attending selected health facilities in rural and suburban areas of Osun State, Nigeria**

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*Correspondence to: adesinaf@oauife.edu.ng; Tel: 08034135898**Abstract:**

Background: Dengue fever, one of the viral infections that shares clinical features with malaria, is a reason for common misdiagnosis and under-reporting in resource-limited places. This cross sectional study was designed to determine the prevalence of Dengue virus (DENV) specific IgM and IgG antibodies among apparently healthy and sick individuals attending health facilities in selected rural and sub-urban areas in Osun State.

Methodology: This was a descriptive cross-sectional study of 164 randomly selected consenting participants visiting some healthcare facilities in selected localities of Osun State, Nigeria, between November 2024 and September 2025. Venous blood samples were collected from participants for the detection of DENV IgM and IgG using rapid diagnostic test kits following the manufacturers instructions. Data were collected with structured questionnaires and analysed using the Statistical Package for Social Sciences (SPSS) v23. Descriptive statistic was used for prevalence estimation, and Chi-square test was used to determine association between variables. Significance level was set at $p \leq 0.05$.

Results: The overall prevalence of DENV IgM among the participants was 7.3% ($n=12/164$) while that of DENV IgG was 14.6% ($n=24/164$). Co-detection of IgM and IgG occurred in 4.9% ($n=8/164$) of the participants. The prevalence of DENV IgM was highest among individuals aged 11-20 years (15.2%, $n=5/33$), followed by aged 61-70 years (9.1%, $n=1/11$) and 21-30 years (8.9%, $n=5/58$). Females had higher DENV IgM and IgG prevalence of 9.7% ($n=11/113$) and 18.6% ($n=21/113$) respectively, compared to males. Spatially, sub-urban dwellers had higher prevalence of DENV IgM (9.7%, $n=6/62$) and IgG (24.2%, $n=15/62$), compared to rural and urban dwellers. A significantly higher prevalence of DENV IgM ($p=0.024$) was observed among artisans (26.7%, $n=4/15$), compared to other occupational groups.

Conclusion: This study shows that Dengue virus infection is present in the population with evidence of both recent (IgM) and previous (IgG) infections, and there is the indication of re-infection, possibility of secondary infections or continuous reactions in the immune system, with the likelihood of pressure on the virus which may lead to mutations of any kind. This calls for surveillance with a wider coverage and laboratory empowerment to avoid misdiagnosis. A larger sample size and molecular analysis would give a better insight into the epidemiology of Dengue in the population.

Keywords: Dengue, detection, antibodies, seroprevalence, rural, sub-urban

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Détection des IgM et IgG anti-dengue chez des individus apparemment sains et malades fréquentant des établissements de santé sélectionnés dans les zones rurales et périurbaines de l'État d'Osun, au Nigéria

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*Correspondance à: adesinaf@oauife.edu.ng; Tél.: 08034135898**Résumé:**

Contexte: La dengue, une infection virale présentant des caractéristiques cliniques similaires à celles du paludisme, est souvent mal diagnostiquée et sous-déclarée dans les régions aux ressources limitées. Cette étude transversale

visait à déterminer la prévalence des anticorps IgM et IgG spécifiques du virus de la dengue (DENV) chez des personnes apparemment saines et malades fréquentant des établissements de santé dans des zones rurales et périurbaines sélectionnées de l'État d'Osun.

Méthodologie: Il s'agit d'une étude transversale descriptive menée auprès de 164 participants consentants, sélectionnés aléatoirement, consultant dans des établissements de santé de localités sélectionnées de l'État d'Osun, au Nigéria, entre novembre 2024 et septembre 2025. Des échantillons de sang veineux ont été prélevés chez les participants pour la détection des IgM et IgG anti-DENV à l'aide de tests de diagnostic rapide, conformément aux instructions du fabricant. Les données ont été recueillies à l'aide de questionnaires structurés et analysées avec le logiciel SPSS (version 23). Des statistiques descriptives ont été utilisées pour estimer la prévalence et le test du χ^2 pour déterminer l'association entre les variables. Le seuil de signification a été fixé à $p \leq 0,05$.

Résultats: La prévalence globale des IgM anti-DENV parmi les participants était de 7,3% ($n=12/164$), tandis que celle des IgG anti-DENV était de 14,6% ($n=24/164$). Une co-détection d'IgM et d'IgG a été observée chez 4,9% des participants ($n=8/164$). La prévalence des IgM anti-DENV était la plus élevée chez les personnes âgées de 11 à 20 ans (15,2%, $n=5/33$), suivie par celle des 61 à 70 ans (9,1%, $n=1/11$) et des 21 à 30 ans (8,9%, $n=5/58$). Les femmes présentaient une prévalence d'IgM et d'IgG anti-DENV plus élevée que les hommes, respectivement de 9,7% ($n=11/113$) et de 18,6% ($n=21/113$). Sur le plan spatial, la prévalence des anticorps anti-DENV IgM (9,7%, $n=6/62$) et IgG (24,2%, $n=15/62$) était plus élevée chez les habitants des zones périurbaines que chez ceux des zones rurales et urbaines. Une prévalence significativement plus élevée d'anticorps anti-DENV IgM ($p=0,024$) a été observée chez les artisans (26,7%, $n=4/15$) comparativement aux autres groupes professionnels.

Conclusion: Cette étude montre que l'infection par le virus de la dengue est présente dans la population, avec des preuves d'infections récentes (IgM) et anciennes (IgG). Elle suggère une possible réinfection, des infections secondaires ou des réactions continues du système immunitaire, susceptibles d'exercer une pression sur le virus et d'entraîner des mutations de toute nature. Ceci souligne la nécessité d'une surveillance plus étendue et d'un renforcement des capacités des laboratoires afin d'éviter les erreurs de diagnostic. Un échantillon plus important et une analyse moléculaire permettraient de mieux comprendre l'épidémiologie de la dengue au sein de la population.

Mots-clés: Dengue, détection, anticorps, séroprévalence, milieu rural, milieu périurbain

Introduction:

Dengue, an undifferentiated fever, asymptomatic or mild febrile disease, that can lead to dengue haemorrhagic fever (DHF), and/or Dengue shock syndrome (DSS) is a viral infection transmitted by *Aedes* spp mosquitoes (mainly *Aedes aegypti* and *Aedes albopictus*). The disease is broadly spread in tropical and subtropical areas of the world (1, 2). The prevalence of dengue has been increasing across the globe with the case reported to WHO rising to 14.6 million in 2024 after 505 430 cases in 2000, and has become endemic in over 100 countries (3). However, in Nigeria, it is endemic yet outbreaks are not properly documented and the actual burden of endemicity is not ascertained due to few or no systematic studies, limited data, insufficient diagnostic potential and misdiagnosis as malaria (4).

In Nigeria, arboviral infections have been reported to be confused with malaria because of the clinical similarity with malaria and the lack of regular surveillance (5). Dengue fever is also regarded as an issue in almost all the states of Nigeria, and one of the most frequent causes of fever diseases that are not correctly diagnosed (6). Dengue occurs both in urban and rural regions with more previous cases common in urban regions (7). The high rate of urbanization has made this arboviral disease an important issue of the urban population as it is aided by overpopulation, improper waste disposal, inadequate housing and garbage,

car waste tires, tin, plastic, among others, which give the proper ecological condition that enables the breeding of urban populations of *Aedes* spp mosquitoes, the vector of the disease. The tropical and subtropical proliferation of urban populations of *Aedes* spp mosquitoes; the lack of effective control of vectors and prevention of infectious diseases have all made the disease to get perpetuated in the urban world (8,9).

The co-detection of specific antibodies to Dengue is crucial to the adaptation of dengue virus and the management of the disease. The aim of this study is to determine the prevalence of Dengue IgM and IgG and the co-detection of same among selected participants in rural and sub-urban localities in Osun State, Nigeria.

Materials and method:

Study design and setting:

This hospital-based study is a cross-sectional design involving apparently healthy individuals and those visiting the selected health-care facilities for mild illness across the Ife Central, Ife East, and Ife North Local Government Areas in Osun State, Nigeria. The study areas have a tropical rainforest climate with high seasonal rainfall and mosquito breeding potential. A questionnaire to obtain socio-demographic data, behaviors and exposure to mosquito, and health history was administered to consenting individuals.

Ethical consideration:

Ethical approval for the study was obtained from the Health Research Ethics Committee of the Institute of Public Health, Obafemi Awolowo University, Ile-Ife, Nigeria. Informed consents of the participants were also obtained.

Study participants, sample size and selection:

The study participants were apparently healthy individuals and those visiting the selected healthcare facilities for mild illness regardless of age and sex. The sample size of 164 was calculated using the Leslie Kish formula (). The health facilities were randomly chosen across the Local Government Areas because of their relatively high patronage. The participants were selected using random sampling technique. Participants with serious health complications, physically weak, and those with severe infections, were excluded from the study.

Data collection:

A structured questionnaire was self-administered to each participant to collect socio-demographic and environmental information. Socio-demographic data collected included age, sex, occupation, educational level, and place of residence (urban, sub-urban or rural). Environmental and exposure-related data included proximity of residence to stagnant water bodies or refuse dumps, history of mosquito bites and outdoor occupational activities.

Sample collection and laboratory analysis:

About 3 ml of venous blood was collected aseptically from each participant. The blood samples were separated by centrifugation at 3,000 rpm for 15 minutes and the serum samples stored at -20°C until analyzed. The serum samples were serologically screened for Dengue virus IgM and IgG using Rapid Test Cassettes (Shandong Highplus Biotech, China). Results were recorded after 15 minutes as positive or negative according to the manufacturers instructions.

Statistical analysis:

The data collected with the questionnaires and laboratory procedures were analyzed using Statistical Package for Social Sciences (SPSS) v23. Descriptive statistics were used to determine prevalence, and Chi-square tests assessed associations between variables. Significance was set at $p \leq 0.05$.

Results**Sociodemographic characteristics of the study participants:**

Of the 164 participants selected for the

study, 51 (31.1%) were males while 113 (68.9 %) were females. The age group 21-30 years is the most represented ($n=56$, 34.1%) while age group 71-80 years is the least represented ($n=2$, 1.2%). The participants are mostly from semi-urban (37.8%, $n=62$), followed by rural (32.9%, $n=54$) and urban (29.3%, $n=48$) settlements, and were recruited mostly from primary health care facility (65.4%, $n=107$) and private facility (32.9%, $n=54$) while only 3 (1.8%) were from secondary healthcare facility (Table 1). The mean age of the 164 participants was 29.06 (SD = 18.17) years while the modal and median ages are 25 years and 24 years respectively.

Prevalence of Dengue IgM and IgG among the study participants:

Of the 164 participants, 12 (7.3%) were Dengue IgM positive, 24 (14.6%) were Dengue IgG positive, while 8 (4.9%) were positive for both Dengue IgM and IgG. Participants in the age group 11-20 years had the highest prevalence of DENV IgM (15.2%, $n=5/33$) followed by age group 21-30 years (8.9%, $n=5/56$), but the prevalence difference with respect to age was not statistically significant ($p=0.448$). The prevalence of DENV IgG was lowest in age group 0-10 years (5.3%, $n=1/19$) and highest in the age group 71-80 years (50.0%, $n=1/2$), but the prevalence difference was also not statistically significant with respect to age ($p=0.537$) (Table 1).

The prevalence of DENV IgM of 9.7% ($n=11/113$) for the female participants is higher than 2.0% ($n=1/51$) for the male participants, but the difference was not statistically significant ($p=0.077$). However, the prevalence of DENV IgG of 18.6% ($n=21/113$) for the female participants was significantly higher than 5.9% ($n=3/51$) for the male participants ($p=0.033$). Participants from suburban settlement had significantly higher prevalence of DENV IgG (24.2%, $n=15/62$) than participants from other settlements ($p=0.021$) but there was no significant difference in DENV IgM with respect to settlement type ($p=0.658$). Although participants from primary healthcare (HC) facility had higher prevalence of DENV IgM (10.3%, $n=11/107$) and DENV IgG (17.8%, $n=19/107$) than participants from secondary and private facilities, the prevalence difference was not statistically significant ($p=0.135$ and $p=0.273$ respectively) (Table 1).

Prevalence and distribution of the study participants positive for both DENV IgM/IgG with respect to location:

The prevalence and distribution of the study participants positive for both Dengue IgM

Table 1: Prevalence and distribution of dengue IgM and IgG antibodies among participants in Ile-Ife and environs

Characteristics	Participants (n)	DENV IgM			DENV IgG		
		+ve (%)	-ve (%)	p value	+ve (%)	-ve (%)	p value
Age group (years)	0-10 (n=19)	0	19 (100.0)	0.448	1 (5.3)	18 (94.7)	0.537
	11-20 (n=33)	5 (15.2)	28 (84.8)		6 (18.2)	27 (81.8)	
	21-30 (n=56)	5 (8.9)	51 (91.1)		6 (10.7)	50 (89.3)	
	31-40 (n=22)	1 (4.5)	21 (95.5)		4 (18.2)	18 (81.8)	
	41-50 (n=8)	0	8 (100.0)		1 (12.5)	7 (87.5)	
	51-60 (n=13)	0	13 (100.0)		2 (15.4)	11 (84.6)	
	61-70 (n=11)	1 (9.1)	10 (90.9)		3 (27.3)	8 (72.7)	
	71-80 (n=2)	0	2 (100.0)		1 (50.0)	1 (50.0)	
	Total (n=164)	12 (7.3)	152 (92.7)		24 (14.6)	140 (85.4)	
Sex	Male (n=51)	1 (2.0)	50 (98.0)	0.077	3 (5.9)	48 (94.1)	*0.033
	Female (n=113)	11 (9.7)	102 (90.3)		21 (18.6)+	92 (81.4)	
	Total (n=164)	12 (7.3)	152 (92.7)		24 (14.6)	140 (85.4)	
Settlement type	Rural (n=54)	3 (5.6)	51 (94.4)	0.658	6 (11.1)	48 (88.9)	*0.021
	Sub-urban (n=62)	6 (9.7)	56 (90.3)		15 (24.2)+	47 (75.8)	
	Urban (n=48)	3 (6.3)	45 (93.8)		3 (6.3)	45 (93.8)	
	Total (n=164)	12 (7.3)	152 (92.7)		24 (14.6)	140 (85.4)	
Health facility	Primary HC (n=107)	11 (10.3)	96 (89.7)	0.135	19 (17.8)	88 (82.2)	0.273
	Secondary HC (n=3)	0	3 (100.0)		0	3 (100.0)	
	Private facility (n=54)	1 (1.9)	53 (98.1)		5 (9.3)	49 (90.7)	
	Total (n=164)	12 (7.3)	152 (92.7)		24 (14.6)	140 (85.4)	

* = Statistically significant; + = significantly higher prevalence; n = number of participant; DENV = Dengue virus

Table 2: Distribution of participants positive for both dengue IgG and IgM with respect to locations

Locations	Dengue IgM	Dengue IgG		Total
		Negative	Positive	
Akarabata (n=5)	Negative	5	0	5
	Positive	0	0	0
Edunabon (n=12)	Negative	11	1	12
	Positive	0	0	0
Enuwa (n=20)	Negative	17	0	17
	Positive	0	3 (15.0%)	3
Ipetumodu (n=8)	Negative	8	0	8
	Positive	0	0	0
Modakeke (n=17)	Negative	10	4	14
	Positive	0	3 (17.6%)	3
OAU Campus (n=43)	Negative	38	2	40
	Positive	2	1 (2.3%)	3
Okookan (n=1)	Negative	1	0	1
	Positive	0	0	0
Sabo (n=1)	Negative	1	0	1
	Positive	0	0	0
Sooko (n=16)	Negative	11	3	14
	Positive	2	0	2
Wanikin (n=25)	Negative	23	1	24
	Positive	0	1 (4.0%)	1
Yakooyo (n=16)	Negative	11	5	16
	Positive	0	0	0

and IgG according to location is shown in Table 2. The prevalence of DENV IgG/IgM was 17.6%

(n=3/17) for participants from Modakeke, 15% (n=3/20) for Enuwa, 4.0% (n=1/25) for Wani-

kin, and 2.3% (n=1/43) for OAU Campus. With respect to sex of the 8 participants positive for both DENV IgG and IgM, 6 were females (75%); 3 (37.5%) from Enuwa and 3 (37.5%) from Modakeke, while 2 were males (25.0%). However, the prevalence of both DENV IgM and IgG of 3.9% (n=2/51) in the males is not significantly different from 5.3% (6/113) in the females ($p=1.000$). All the participants positive for both DENV IgM and IgG were from the sub-urban study areas.

Predisposing factors for DENV infection:

In Table 3 on predisposing factors to DENV infection, occupation of the participants was significantly associated with DENV IgM positivity (p -value of 0.024). The prevalence of DENV IgM (recent Dengue virus infection) was significantly higher among artisans (26.7%, n=4/15) compared to traders (3.7%, n=2/54), civil servants (5.9%, n=1/17) and unemployed (6.4%, n=5/78) ($p=0.024$).

Discussion:

This study shows that there are recent and past Dengue virus infections in rural and suburban regions of Osun State, Nigeria as indicated by the presence of dengue IgM and IgG antibodies in the selected participants. The fact that there is a higher prevalence of IgG (14.6%) over IgM (7.3%) indicates that a high proportion of the population in the study setting had prior exposure to the Dengue virus thus, suggesting continuous Dengue transmission in the study area. This situation is likely to be

similar to other regions of Nigeria and sub-Saharan Africa, where the transmission of Dengue is persistent, neglected, and hence under-reported because of insufficient routine diagnostics and likely misdiagnosis with malaria or other febrile diseases (9).

The co-detection of dengue IgM and IgG antibodies in the study participants is epidemiologically important because it indicates secondary infections occurring in people who were previously exposed to it. The secondary dengue infection has been reported to enhance the possibility of having severe clinical manifestations because of antibody-dependent enhancement, which has been well reported in dengue pathogenesis (10). The same patterns of co-detection were reported in other studies in Nigeria and other endemic countries, where people with a history of exposure are prone to infection with other dengue serotypes, hence leading to disease severity and persistence of infection (11,12). Molecular analysis will help to ascertain the predominant serotypes and hence the disease could be better managed.

The high prevalence of Dengue IgM and IgG among the age group of 11-20 years indicates that young adults and more active groups of the population might be at a higher risk of Dengue virus infection. It is also worth noting that DENV IgG prevalence increased progressively from the 41-50 to 71-80 years. Reasons for this may be due to their profession, travel history, and behavioural patterns which have exposed them to the daytime feeding *Aedes* mosquitoes.

Table 3: Predisposing factors to Dengue virus infections among the study participants

Characteristics	Responses	DENV IgM		p value
		+ve (%)	-ve (%)	
Time Indoor (n=145)**	Around 6pm	3 (8.1)	34 (91.9)	0.690
	Around 8pm	6 (8.6)	64 (91.4)	
	Around 10pm	3 (7.9)	35 (92.1)	
Recent Mosquitoes Bite (n=144)**	No	2 (8.0)	23 (92.0)	0.692
	Yes	5 (5.1)	93 (94.9)	
	Not sure	2 (9.5)	19 (90.5)	
Residence infested with Mosquitoes (n=144)**	No	2 (5.6)	34 (94.4)	0.500
	Yes	7 (7.6)	85 (92.4)	
	Yes, but seasonal	0	16 (100.0)	
Occupation (n=164)	Trading	2 (3.7)	52 (96.3)	*0.024
	Artisan	4 (26.7)*	11 (73.3)	
	Civil Servant	1 (5.9)	16 (94.1)	
	Not Employed	5 (6.4)	73 (93.6)	
Live close to Stagnant water (n=164)	Yes	7 (13.0)	47 (87.0)	0.52
	No	5 (4.5)	105 (95.5)	

*Statistical significance; **Based on number of participants who responded to the questionnaires; *significantly higher prevalence

The increasing prevalence of the IgG among the elderly ones may be due to their previous exposure and may be suggesting an increased Dengue IgG prevalence in the future since younger ones have high DENV IgM prevalence now. Similar results have been documented in the northern Nigeria and southeast Asia where adolescents and young adults showed greater prevalence of acute Dengue virus infection because they were more mobile and exposed to the environment (3,11).

Although the prevalence of DENV IgM (9.7%) and IgG (18.6%) are higher for the female participants in this study, there may be no special reason for this high prevalence but it may be as a result of female-related roles and behaviors, which expose them to mosquito bites. Women tend to be more engaged in water handling and waste management activities in most African environments thus predisposing them to visiting breeding sites of the mosquito vectors. The reason for the prevalence may therefore be a context-specific phenomenon (9). More studies about the immune response may also be useful to give further explanation for this difference. The transmission patterns are likely to have been aided by environmental and socio-economic factors.

Problems that are common in rural and suburban areas in Osun State include poor waste disposal mechanisms, poor drainage, and use of water storage containers, which are favorable breeding environments for the *Aedes* mosquitoes. These results are consistent with earlier reports claiming that environmental sanitation and water management practices are also among the most important determinants of dengue spread in the endemic areas (13,14). Sub-urban environments tolerate a higher level of mosquitoes because of environmental conditions like open water containers, temperature, and humidity which favor larvae growth and survival of vectors (15).

The co-detection of IgM with IgG suggests that as long as active transmission takes place, a significant percentage of infections might remain unrecognized as febrile diseases, in many resource-deficient facilities, are often treated presumptively as malaria without laboratory verification thus leading to the underestimation of real burden of this disease (16). The growing epidemiological significance of sub-urban regions as crucial areas of Dengue virus transmission was further substantiated by this study with a higher prevalence of the Dengue IgM in the suburban areas. Moreover, spatial

epidemiological empirical evidence shows that hot-spots of Dengue transmission are often rel-

ated to rapidly growing and sub-urban areas whose human mobility, housing configurations, and ecological situations interact and perpetuate transmission cycles (17).

Rising urbanization and environmental transformation have been cited as one of the biggest causes of arboviral pathology emergence such as dengue within the transitional urban-sub-urban zones in sub-Saharan Africa (18). Also, studies in West Africa have proved that peri-urbanization promotes the continued transmission of Dengue as it predisposes humans to develop closer interactions with vectors besides the environment being more favorable (19). This change is a cause of the necessity to have inclusive approaches to public health, which consider urban and non-urban environments.

This study supports the significance of serological surveillance in the detection of recent and previous infections. There is possibility that the observed higher seroprevalence in sub-urban residents in this study indicates an interaction between ecological suitability, the abundance of vectors, and human patterns of exposure, which stress the importance of specific interventions targeting the control of vectors and the environment in high-risk regions. The co-detection of Dengue IgM and IgG antibodies buttresses the risk of second-line infections and a possible severe development of the disease. Enhancing diagnostic capacity, environmental sanitation, and specific interventions in the field of the implementation of vector control are the necessary measures to reduce the burden of dengue in Osun State and other such facilities.

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Contributions of authors:

AOA conceived the idea, was involved in the laboratory analysis and the reading and correction of the manuscript; OAA was involved in sample collection, laboratory analysis and the writing of the manuscript.

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Artificial intelligence was used in part for data presentation and interpretation.

References

1. Abuelmaali, S. A., Jamaluddin, J. A. F., Noaman, K., Allam, M., Abushama, H. M., and Elnaïem, D. E. Distribution and Genetic Diversity of *Aedes aegypti* Subspecies across the Sahelian Belt in Sudan. *Pathogens*. 2021; 10 (1): 78. [doi: 10.3390/pathogens10010078](https://doi.org/10.3390/pathogens10010078)
2. Sharma, P., Pavitra, K., and Shettigar, S. Trends in dengue virus infection with seasonal variation at a tertiary care centre, Mangaluru: a retrospective study. *Int J Med Microbiol Trop Dis*. 2022; 8: 294–317. [doi: 10.18231/j.ijmmtd.2022.057](https://doi.org/10.18231/j.ijmmtd.2022.057).
3. World Health Organization. Dengue and Severe Dengue: Fact Sheet. WHO, 2025
4. Kolawole, O., Seriki, A. A., Irekeola, A. A., and Ogah, J. The Neglect and Fast Spread of Some Arboviruses: A Note for Healthcare Providers in Nigeria. *Diseases*. 2018; 6: 99. [doi: 10.3390/diseases6040099](https://doi.org/10.3390/diseases6040099).
5. Baba, M. M., Logue, C. H., Oderinde, B., et al. Evidence of arbovirus co-infections in suspected febrile malaria and typhoid patients: A worrisome situation in Nigeria. *J Infect Dev Ctries*. 2013; 7 (1): 51–9. [doi: 10.3855/jidc.2411](https://doi.org/10.3855/jidc.2411)
6. Adesola, R. O., Ajibade, F. A., Idris, I., Scott, G. Y., and Agaie, M. I. Addressing the dengue fever challenges in Nigeria: A narrative review and recommendations for control. *Infez Med*. 2024; 32 (2): 157–167. [doi: 10.53854/liim-3202-5](https://doi.org/10.53854/liim-3202-5)
7. Vong, S., Khieu, V., and Glass, O. Dengue incidence in urban and rural Cambodia: Results from population-based active fever surveillance, 2006–2008. *PLoS Negl Trop Dis*. 2010; 4 (11): e903. [doi: 10.1371/journal.pntd.0000903](https://doi.org/10.1371/journal.pntd.0000903).
8. Adesina, O. A., and Adeniji, J. A. Incidence of dengue virus in febrile episodes in Ile-Ife, Nigeria. *Afr J Infect Dis*. 2016; 10: 21–24. [doi: 10.4314/ajid.v10i1.4](https://doi.org/10.4314/ajid.v10i1.4)
9. Dada, J. O., Opaleye, O. O., Igbeneghu, C., et al. Seroprevalence and molecular surveillance for dengue virus infections among febrile patients and mosquito vectors in Ogbomoso, Nigeria. *World J Adv Res Rev*. 2024; 24 (3): 553–570. <https://doi.org/10.30574/wjarr.2024.24.3.3658>
10. Guzman, M. G., Halstead, S. B., Artsob, H., et al. Dengue: a continuing global threat. *Nat Rev Microbiol*. 2010; 8 (12 Suppl): S7–S16. <https://doi.org/10.1038/nrmicro2460>
11. Onyedibe, K., Dawurung, J., Iroezindu, M., et al. A cross-sectional study of dengue virus infection in febrile patients presumptively diagnosed of malaria in Maiduguri and Jos plateau, Nigeria. *Malawi Med J*. 2018; 30 (4): 276–282. <https://doi.org/10.4314/mmj.v30i4.11>
12. Tizhe, D. T., Kwaga, J. K. P., and Nok Kia, G. S. Serological and Molecular Survey for Dengue Virus Infection in Suspected Febrile Patients in Selected Local Government Areas in Adamawa State, Nigeria. *Vaccines*. 2022; 10 (9): 1407. <https://doi.org/10.3390/vaccines10091407>
13. Brady, O. J., Golding, N., Pigott, D. M., et al. Global temperature constraints on *Aedes aegypti* and *Aedes albopictus* persistence and competence for dengue virus transmission. *Parasites & Vectors*. 2014; 7: 338. <https://doi.org/10.1186/1756-3305-7-338>
14. Achee, N. L., Gould, F., Perkins, T. A., et al. A critical assessment of vector control for dengue prevention *PLoS Negl Trop Dis*. 2015; 9 (5): e00036555. <https://doi.org/10.1371/journal.pntd.0003655>.
15. Wiyata, A. D., Handoyo, W., and Sayono, S. The Key Associated Factor of the Emergence of the Dengue Vector in Peri-Urban and Rural Settlements. *Jurnal Kesehatan Lingkungan*. 2023; 15 (4): 291–299. <https://doi.org/10.20473/jkl.v15i4.2023.291-299>
16. Amarasinghe, A., Kuritsk, J. N., Letson, G. W., and Margolis, H. S. Dengue virus infection in Africa. *Emerg Infect Dis*. 2011; 17 (8): 1349–1354. <https://doi.org/10.3201/eid1708.101515>
17. Dom, N. C., Hisyam, A. N. S., Saeman, M. N., et al. Housing structure shapes dengue transmission dynamics in a rapidly urbanizing Malaysian district. *Sci Rep*. 2026; 16 (1): 6840. <https://doi.org/10.1038/s41598-026-35904-9>.
18. Weetman, D., Kamgang, B., Badolo, A., et al. *Aedes* Mosquitoes and *Aedes*-Borne Arboviruses in Africa: Current and Future Threats. *Int J Environ Res Publ Health*. 2018; 15 (2): 220. <https://doi.org/10.3390/ijerph15020220>
19. Messina, J. P., Brady, O. J., Scott, T. W., et al. Global spread of dengue virus types: mapping the 70-year history. *Trends Microbiol*. 2014; 22 (3): 138–146. <https://doi.org/10.1016/j.tim.2013.12.011>