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# Arboviruses, an Emerging Threat to Public Health: Focus on Nigeria, West Africa

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ABSTRACT

**Backgrounds:** For centuries, arboviruses have been spreading like a wildfire across the world, especially in developing countries like Nigeria with inadequate diagnostic and disease surveillance facilities, causing infinite death and suffering in human and animal populations. Therefore, this study aimed to discuss the impact of arboviruses on public health with a focus on Nigeria and West Africa.
**Materials & Methods:** About 100 research articles were downloaded from online journal databases such as PubMed, Google Scholar, and African Journals OnLine (AJOL) with the following keywords: arboviruses, emerging, public health importance, Nigeria, and Africa.
**Findings:** A total of 50 articles were used to write this review after a thorough screening. Arboviral infections caused by yellow fever, Rift Valley fever, West Nile, dengue, and chikungunya viruses were reported in Nigeria and discovered based on seroprevalence studies.
**Conclusion:** Hemorrhagic fever, abortion, neonatal death, and decreased production in livestock are the most obvious features of arboviral infections; therefore, they are of public health and economic importance. Thus, there is a need to strengthen and refurbish the healthcare system in the country by employing preventive and control measures, vaccination campaigns, and other strategies to prevent the occurrence of diseases in the future.

**Keywords:** Arboviruses, Emerging, Nigeria.

CITATION LINKS

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## Introduction

Arboviruses, also known as arthropod-borne viruses, are a large and diverse group of viruses with more than 500 species worldwide [1], these viruses are transmitted to susceptible hosts by numerous infected arthropod vectors, including insects, ticks, sandflies, and midges [2]. Arboviruses are a considerable threat to human and animal health worldwide as several of them are found in different parts of the world, including Africa. During the past 60 years, numerous arboviruses have been reported in Nigeria, some of which were identified between the 1950s and 1980s [3]. Most arboviruses belong to the families *Flaviviridae* and *Togaviridae* and the order *Bunyavirales,* and a few belong to the *Reoviridae*, *Orthomyxoviridae* [4], *Rhabdoviridae*, and *Asfarviridae* families [5]. These viruses affect both humans and animals; however, they possess a strong ability to cross international boundaries. Arboviruses cause multi-systemic infections characterized by features such as hemorrhagic fever, jaundice, meningitis, encephalitis, etc. Diseases caused by these viruses are of public health and economic importance as they cause severe animal and human mortality in Nigeria. Therefore, knowing and updating our knowledge about arboviruses is essential for effective control of these viruses. This review aimed to elaborate on the public health importance of arboviruses in the Nigeria context.

## Materials and Methods

In this review, about 100 research articles were downloaded from online journal databases such as PubMed, Google Scholar, and African Journals OnLine (AJOL). Articles were selected and downloaded based on proximity to the searched keywords (arboviruses, emerging, public health importance, Nigeria, and Africa).

## Findings

After proper checking and thorough reading of the downloaded articles, approximately 50 articles were used in writing this review article. Arboviral infections caused by yellow fever, Rift Valley fever, West Nile, dengue, and chikungunya viruses were reported in Nigeria and discovered based on seroprevalence studies.

## Discussion

### *Flaviviridae*

The family *Flaviviridae* consists of four genera including *Flavivirus, Pestivirus, Hepacivirus,* and *Pegivirus*. The *Flavivirus* genus is made up of about five species infecting mosquitoes and ticks, with mammals and birds serving as primary hosts. Yellow fever, West Nile, dengue, Japanese encephalitis, and tick-borne encephalitis viruses are flaviviruses that usually affect humans [6]. Pestiviruses usually affect animals, particularly bovines and pigs. They comprise bovine viral diarrhea virus type 1(BVDV-1), bovine viral diarrhea virus type 2(BVDV-2), classical swine fever virus (CSFV), and border disease virus [7]. *Hepacivirus* is associated with liver Hepatitis C virus that causes liver infections, while *Pestivirus* is distributed among mammals and causes persistent infections.

The genus *Flavivirus* is associated with most pathogenic infections and is of great public health importance, while it is usually neglected in African countries, particularly Nigeria, because of inadequate surveillance and very little research. Looking at the yellow fever virus in Nigeria, according to the World Health Organization (WHO), about 1,312 suspected cases of yellow fever virus were reported in 367 local governments across the country from September 2017 to January 2021, these cases were mostly reported in the southern part of the country where the annual rainfall was high; however, there's a wide research gap in other parts

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of the country, which need to be addressed. According to the WHO, Nigeria also recorded a very wide gap in achieving herd immunity against the yellow fever virus, which is mostly transmitted through the bites of infected mosquitoes but not directly from person to person. However, it could be transmitted through direct contact with contaminated blood products or animal carcasses, and even from animals to humans.

Another important arboviral infection that belongs to the *Flavivirus* genus is West Nile virus. West Nile virus usually persists in the zoonotic transmission cycle between birds and mosquitoes, specifically *Culex* species [8], where reptiles, mammals, amphibians, and other vertebrates are susceptible to the virus [9]. West Nile virus was first identified in an East African country (Uganda) in 1937, where it further spread to other countries because of international travels, land use, and globalization. In Nigeria, West Nile virus infection was first identified in 1959 based on a serological test [10] which showed that the southwest and northeast regions had the highest sero-prevalence, this could be attributed to the availability of virology laboratories in these areas, whereas the absence of these laboratories in other zones may have led to the misdiagnosis of West Nile virus with other infections [11]. West Nile virus infection shares similar symptoms with other febrile-related illnesses; therefore, this infection could be misdiagnosed with malaria which is endemic in Nigeria. However, cross-sectional studies conducted in Kaduna state, located in the northern part of Nigeria, have shown that West Nile fever virus antigen is widespread in different locations of the state [12]. West Nile virus infection could also be detected in almost any region of the country because of its similar mode of transmission to malaria, especially in areas with high amounts of rainfall and widespread mosquitoes.

Dengue virus causes hemorrhagic fever known as dengue hemorrhagic fever, which is characterized by high morbidity and mortality and considered as an emerging infection in Nigeria [13]. The widespread *Aedes* mosquito in Nigeria serves as an important vector for this infection; serological studies conducted in Kano state have shown the existence of dengue virus in Nigeria [14]. In Osun state in southwestern Nigeria, the incidence of dengue infection has been identified in patients with febrile symptoms [15]. Moreover, dengue virus has also been identified in patients with fever in Lagos state, Nigeria [16].

### *Bunyavirales* (formerly the *Bunyaviridae* family)

*Bunyavirales* is an order of single-stranded, spherical, enveloped, RNA viruses (formerly known as the *Bunyaviridae* family) [17]. The virus families in the *Bunyavirales* order that cause viral hemorrhagic fevers include *Phenuiviridae, Arenaviridae*, *Nairoviridae*, and *Hantaviridae* [17,18]. The distribution of these viruses is determined by the vector and host species distribution.

The genus *Hantavirus* is not distributed in African countries, whereas *Phlebovirus, Arenavirus,* and *Nairovirus* are distributed in Africa, Asia, and Europe. *Phlebovirus* has a single species called Rift Valley fever virus, which is distributed in African countries. The *Nairovirus* genus consists of Nairobi sheep disease virus found in East Africa and Crimean-Congo hemorrhagic fever virus found in Africa, Asia, and Europe. The family *Arenaviridae* is composed of two subgroups: new-world and old-world arenaviruses. The new world group of *Arenaviridae* is found in North and South America, for example, Chapare virus, while the old world group is found in Africa, Asia, and Europe, for example, Lassa fever virus. *Bunyavirus*, *Nairovirus*, and *Phlebovirus* are transmitted by blood-feeding arthropods, while *Arenaviridae* and *Hantavirus* are transmitted by rodents [19].

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In Nigeria, the most medically important virus among the *Bunyaviridae* viruses is Rift Valley fever virus which is found in different regions based on serological studies conducted.

Rift Valley fever affects humans and animals and is characterized by hemorrhagic fever, meningitis, gastroenteritis, and massive abortion in animals. Rainfall and floods are the major factors that enhance the occurrence of this disease in a population.

***Togaviridae***

This family is made up of the *Alphavirus* genus which consists of 26 species [20]. Alphaviruses are transmitted to vertebrates and non-vertebrates through mosquito, which is usually found in the ecology, their hosts range from animals to other arthropod species, and infection caused by alphaviruses in humans is characterized by febrile illness, encephalitis, and other CNS (central nervous system) disorders.

Alphaviruses that are transmitted by mosquitoes are divided into new-world and old-world alphaviruses based on geographical location [21]. Mosquito-borne alphaviruses are generally subdivided based on their geographic origin. New-world alphaviruses include Venezuelan, western, and eastern equine encephalitis viruses, which are associated with encephalitis in horses and humans, while old-world alphaviruses include Sindbis virus group, Barmah Forest virus, O'nyong'nyong virus, Ross River virus, Semliki Forest virus, and chikungunya virus, which are associated with fever, rashes, arthralgia, and arthritis [22].

***Matonaviridae***

Rubella virus is the only member of the *Rubivirus rubellae* species belonging to the family *Matonaviridae*. Humans are the only natural host of this virus; therefore, it's medically important to humans where it causes a disease called rubella or 3-day measles. It causes a systemic infection which is characterized by mild rashes for a short period and arthritis [23].

Rubella usually occurs during the first three months of pregnancy, and the virus usually crosses the placenta and affects the fetus, resulting in malformations referred to as congenital rubella syndrome [24].

**Arboviral infections as a threat to public health**

There are several species of arboviruses in Nigeria; however, little research has been conducted on the epidemiology of these viruses. In addition, mosquitoes (*Aedes* spp*., Culex* spp.) that transmit infections like yellow fever, dengue, and chikungunya are widely distributed and prevalent in the northeastern part of Nigeria [25]. In Nigeria, all febrile conditions or illnesses are attributed to malaria due to its endemic nature in the country, unless there's a confirmed laboratory diagnosis [25]. Seropreva-

**Table 1)** Summary of the families and species of arboviruses in Africa

| Families | Species |
|---|---|
| *Flaviviridae* | Yellow fever virus, West Nile virus, dengue virus, Japanese encephalitis virus, tick-borne encephalitis virus, bovine viral diarrhea virus type 1(BVDV-1), bovine viral diarrhea virus type 2(BVDV-2), classical swine fever virus (CSFV), border disease virus, and Hepatitis C virus. |
| *Phenuiviridae* | Rift Valley fever virus |
| *Arenaviridae* | Lassa fever virus |
| *Nairoviridae* | Nairobi sheep disease virus and Crimean-Congo hemorrhagic fever virus |
| *Togaviridae* | Sindbis virus, Barmah Forest virus, O'nyong'nyong virus, Ross River virus, Semliki Forest virus, and chikungunya virus |
| *Matonaviridae* | *Rubivirus* |

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lence studies conducted in the northeastern part of Nigeria have shown the presence of widespread antibodies against many arboviruses like yellow fever, West Nile, dengue, and chikungunya viruses [11].

About 65 years ago, several arboviruses were reported in Nigeria, where most of these viruses have now acquired endemic status of human and veterinary importance. However, this report was achieved due to the availability of virology laboratories, veterinarians, and laboratory professionals and increased surveillance systems and diagnostic tools [26].

In Nigeria, numerous species of mosquitoes have been discovered, and these mosquitoes are important vectors associated with the majority of arboviral infections. Studies conducted in Ibadan, located in the southwest of Nigeria, have shown that there are abundant species of *Culex* and *Anopheles gambiae* mosquitoes, whereby *Culex* species are dominant [27].

The transmission of arboviruses from animals to humans has been reported, while human-to-animal and human-to-human transmission is uncommon [28], evidence shows that the virus could be transmitted through blood works, such as transfusion and organ transplant [29]; therefore, healthcare workers are at risk of arboviral infections. Arbovirus transmission from infected animals or humans through needles is also possible [30].

In Nigeria, previous research has shown that yellow fever, dengue fever, West Nile, chikungunya, and Rift Valley fever viruses are highly prevalent and associated with several predisposing factors, these factors include age, human and animal exposure to mosquitoes, housing, lack of knowledge and awareness on arboviral infections, and contact with livestock [31].

Arboviruses are widely distributed in Nigeria, but their prevalence may differ in certain geographical locations based on the availability of vectors (mosquitoes), the level of hygiene, the amount of rainfall, and inadequate water channels. Arboviral infection is associated with high morbidity and mortality, it has endangered countless lives in both human and animal populations. To the best of our knowledge, there's no accurate data on the death number and prevalence of arboviral infections in Nigeria despite the increased infection rates, this may be attributed to the following factors or reasons:

**Poor surveillance**: Arboviral infections are neglected in Nigeria despite the increased infection rates. This virus is distributed all over the country, but surveillance and research are conducted in a few locations and only if there are suspected cases or outbreaks in such areas.

**Improper diagnosis:** Arboviral infections share similar symptoms to malaria, typhoid, and other bacterial infections. Therefore, infections with arboviruses are considered malaria in most hospitals due to their feverish characteristics, and healthcare workers don't investigate further to confirm the diagnosis, thereby leading to incorrect treatment and treatment failure attributed to antimicrobial resistance.

**Lack of diagnostic tools:** Nigeria is a developing country with poor health care services. There are no adequate virology laboratories to diagnose viral infections, particularly arboviruses that are of great public health importance.

**Lack of awareness:** There is no public awareness of the dangers associated with arboviral infections, the virus distribution, and most importantly, how the virus is transmitted among populations and from animals to humans (zoonotic implications).

**Poverty**: On average, Nigerians could not afford hospital bills, from file opening and laboratory tests to medical and treatment costs. These factors prevent them from referring to hospitals to receive effective treat-

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ment; thus, they resort to self-medication with over-the-counter or herbal medicines. However, this factor might lead to persistent illness and death.

**Recommendations and Conclusion**

Arboviruses pose many dangers to humans and animals due to their public health and economic importance, resulting in death, decreased production of milk and other products in livestock, abortion, and embryonic death. In conclusion, several essential strategies and approaches need to be implemented to provide an effective solution to the dangers imposed by arboviruses. These measures include:

**Destruction of vectors and their breeding sites:** Mosquitoes are everywhere in Nigeria. Therefore, their breeding sites should be destroyed through the construction of drainage and water channels, following strict hygiene and sanitation principles, and preventing humans and livestock from mosquito bites by using mosquito nets and insecticides in households and animal houses.

**Education and public enlightenment:** Healthcare workers, especially those working with blood and other blood products, should be educated on the routes of transmission of arboviruses and the use of personal protective equipment to prevent infection and protect themselves. Also, the general public should be enlightened on the dangers and threats of arboviruses, preventive measures, and control of infections in a population.

**Routine surveillance:** Whenever there is an unknown infection or outbreak, reports and other important information should be timely collected and collated from farmers and animal handlers in every geographical location, this is a step forward to prepare for outbreaks and re-emerging infections.

**Vaccination:** Vaccines against arboviruses should be timely provided for mass vaccination of humans and livestock (annual vaccination), this serves as an excellent tool to prevent disease outbreaks and create herd immunity.

Finally, the government and other non-governmental agencies should provide funding for research on arboviruses, diagnostic tools in hospital settings, and the development of antiviral drugs and vaccines against arboviral infections.

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