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# Mosquito-borne diseases in Assam

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### Abstract

Mosquito-borne diseases are of major public health concern in the northeastern state of Assam, India. The most common among them include Malaria, Dengue, Japanese encephalitis (JE), and Lymphatic filariasis (LF), while Malaria and JE being predominant and spread across the state. Although malaria outbreaks are common in Assam, their incidence has gradually declined in the past few years. Formerly JE was endemic in upper Assam, but it has become common in almost all the districts of the state. Dengue is prevalent in urban and semi-urban areas, and most of the cases have been reported from Guwahati, the largest metropolitan city of Assam. Distribution of Lymphatic filariasis (LF) is confined to a few districts and is common among the tea-garden workers. Poor socioeconomic status and inability to access proper healthcare services are conducive to the disease occurrence and spread. Application of strong disease surveillance and integrated vector management on a sustained basis based on sound epidemiological data is imperative. This review aims to overview the most common mosquito-borne diseases in Assam and their control measures.

**Keywords:** Assam, Northeast India, malaria, Japanese encephalitis, dengue, lymphatic filariasis

### 1. Introduction

Vector-borne diseases (VBDs) have become a primary concern worldwide, particularly in the tropical and subtropical regions. They account for over 17% of all infectious diseases <sup>[1]</sup>, causing more than 1 million deaths annually. Vectors are those organisms that are capable of transmitting diseases between humans or from animals to humans. Southeast Asian region harbors numerous vector-borne diseases, including mosquito-borne diseases (malaria, dengue, Japanese encephalitis, lymphatic filariasis), sandfly-borne diseases (kala-azar), and snail-mediated diseases (schistosomiasis). Among these, mosquitoes are the best-known among several other vectors like ticks, flies, sandflies, fleas, etc. Most VBDs share some common socioeconomic determinants, including people's inability to access proper health services, poor housing, sanitation, and water supplies <sup>[2]</sup>. Although most of these diseases can be cured or prevented, while some may be fatal if not treated, and some may leave people disfigured and disabled. Malaria, dengue, Chikungunya, lymphatic filariasis, and kala-azar are among the VBDs of significant health concern in Southeast Asia. Dengue is among the world's fastest-growing VBDs, with a 30-fold increase in incidence over the past 50 years. As estimated by WHO, there are 50-100 million dengue infections worldwide every year <sup>[1]</sup>. These VBDs cause considerable illness and deaths in India, thus contributing most cases to the World Health Organization (WHO) South-East Asia Region <sup>[3]</sup>. In South-East Asia, India is a highly populated country affected by malaria, with more than 400 million people at risk of infection <sup>[4]</sup>. 4% of India's population is contributed by the north-eastern states, which harbor VBDs with the indigenous transmission. Among the north-eastern states, Assam constitutes 70% of the total population. More than 80% of Assam's population are rural, while 36% live below the poverty line <sup>[3]</sup>. Although the country's transmission rates vary from low to moderate, the diseases are comparatively more prevalent in population groups living in remote/forest fringe, tribal belts of eastern and north-eastern states contributing over 65% of disease outbreaks <sup>[5]</sup>. The major occupations for the people of Assam for livelihood are paddy cultivation, tea plantations, livestock rearing, and sericulture. Assam has a subtropical climate with hot and humid summers and severe monsoons followed by mild winters. Moreover, many parts of the state are affected by floods every year. Also, the high relative humidity throughout the year are conducive for the proliferation of mosquito vectors and disease transmission <sup>[3]</sup>.

Changes in environmental conditions influence the occurrence and spread of many infectious diseases of humans and animals [6]. Uncontrolled population growth due to migration, rapid urbanization, industrialization, and ecological disturbances create vector proliferation opportunities and increase disease transmission rates. Among the mosquito-borne diseases, malaria, Japanese encephalitis (JE), dengue, and lymphatic filariasis are prevalent in Assam. Malaria and JE are predominant and widely spread across the state. Despite having healthcare infrastructure and disease management schemes, these diseases continue to pose a severe threat to the people of the state and other north-eastern states [3]. Therefore, in this review, we tried to overview the predominant mosquito-borne diseases in Assam, their status and control measures.

## 2. Mosquito-borne diseases

### 2.1 Malaria

Malaria outbreaks are common in Assam [7] and are among the major mosquito-borne disease prevalent in the state [3]. It is associated with a high level of morbidity and mortality [8]. Transmission is primarily maintained by *Anopheles minimus* vectors [9]. However, disease transmission intensities vary across the districts ranging from low to moderate [3, 10]. Assam is endemic to both *Plasmodium falciparum* and *P. vivax* [9]. Almost all the districts of the state are co-endemic to *P. falciparum* and *P. vivax* [3]. Nearly all the state districts are vulnerable to focal malaria outbreaks, out of which 58-68% cases are due to *P. falciparum* while the remaining due to *P. vivax* [11]. Assam contributes more than 5% of the total malaria cases in the country. This vulnerability to malaria transmission is excessive rainfall, increasing vector breeding sites, and prolonged humidity causing vector longevity and warmer climate for most of the year [10]. High rise in the cases are encountered during April-September [3]. With its favorable subtropical climate, Assam offers mosquito fauna better opportunities for diverse and vast breeding sites throughout the year [12]. Transmission depends on several potential vector species, including *Anopheles minimus*, *An. fluviatilis*, *An. dirus* having high vectorial capacity [11, 12]. *An. Minimus* was found to be the most efficient vector as compared to *An. fluviatilis* and *An. dirus* for the transmission of *P. falciparum*. Foot-hill villages associated with forest-associated activities and having seepage water streams have a higher incidence of malaria than the plains. Nevertheless, several other factors, including the inability to access proper healthcare facilities and the low socioeconomic status of population groups in the peripheral districts, increase malaria risk. Moreover, the housing conditions are better in the town areas, which decreases access to vectors. The people are much aware of the disease and its prevention and have access to better healthcare facilities [11]. However, large concentration of cases are encountered in the marginalized population groups of a few districts namely Karbi Anglong, North-Cachar Hills (Dima Hasao), Chirang, Kokrajhar and Udalguri that share international border with Bhutan. These districts have large forest cover and are mostly inhabited by indigenous ethnic tribes living under impoverished conditions with lack of awareness regarding the disease prevention and treatment. The people of these region have poor access to health-care facilities [3]. Multiple-drug resistant *P. falciparum* malaria parasite is prevalent in certain parts of northeastern states in India, including Assam [13]. Resistance in the parasites has

multiplied since the first detection of chloroquine-resistant malaria in Karbi Anglong in 1973 [3]. More than 100 deaths annually in the state are due to confirmed *P. falciparum* parasites [9]. Districts of lower Assam are comparatively more prone to malaria than upper Assam. Although *P. falciparum* is the major parasite in the state but for some districts, including Barpeta, Darrang, Dhemaji, Lakhimpur, Sonitpur, Tinsukia, and Golaghat, *P. vivax* cases exceeded *P. falciparum* [10]. As envisaged by WHO, scientific approaches feasible in elimination of malaria include case surveillance, early diagnosis using rapid diagnostic kits [3]. Several vector control strategies include application of dichloro-diphenyl-trichloroethane (DDT), malathion, dieldrin etc [4] and also indoor residual spraying and use of long-lasting insecticidal nets (LLINs) have proven as an effective tool to control malaria transmission [3]. An attempt was also made by the government of Assam to introduce the use of larvivorous fish as a biological control in some selected districts [9]. Furthermore, community participation and awareness programmes are necessary to prevent habitat creation for vector proliferation, to improve public health services, access to the services by people living in impoverished condition in remote areas [3].

### 2.2 Dengue

Dengue, an arboviral disease, is rapidly becoming a severe health concern with increased incidences in Assam. The potential vectors for dengue transmission are *Aedes albopictus* and *Ae. aegypti*. The preferable breeding habitats for these vectors are discarded tyres, plastic containers, solid waste containers, bamboo stumps, etc [3]. Accumulation of rainwater in these waste materials becomes breeding grounds for the *Aedes* mosquitoes [14]. *Ae. aegypti* prefers mostly solid waste containers while *Ae. albopictus* predominantly breeds in open waste materials [15]. Both the species are prevalent in India's northeast region, thus increasing vector proliferation and disease transmission [16]. These mosquito vectors usually bite during the day, particularly in the early morning and evening, contributing to disease transmission at any time of the day [14]. About 237 dengue cases have been reported from Assam in 2010, followed by 1058 and 4526 cases in 2012 and 2013, respectively, with the majority of the cases reported from Guwahati, the largest metropolitan city of Assam [3, 16]. Guwahati is the gateway to the northeast of India for economic activities. It is also a center for cultural, political and trade, and commerce in the entire northeast of India. Though most of the cases have been reported from Guwahati, confirmed cases have also been reported from other districts [16]. The signs and symptoms of dengue include high fever, headache, nausea, muscle and joint pain, difficulty in respiration, skin rashes, etc. All age groups of both sexes are infected, with a significantly higher incidence in adult males [3]. Ecological changes due to rapid urbanization and industrialization and other anthropogenic activities have contributed to the *Aedes* mosquito breeding and composition in the state [15]. It is projected that dengue will emerge as a significant public health concern in northeast India due to unplanned urbanization, industrialization, and changing climatic conditions. Besides malathion fogging and personal protection measures for containment of dengue, the state control programme has undertaken an intensive health-awareness campaign to prevent and control mosquito breeding. Community level action and awareness in

collaboration with local civic bodies is necessary to prevent and control vector breeding [3].

### 2.3 Japanese Encephalitis (JE)

Japanese encephalitis (JE), an arboviral infection transmitted by the bites of female mosquitoes, belong to *Culex* groups [17]. JE has been a considerable disease burden in the Indian subcontinent since the 1960s. Sporadic outbreaks of JE are common in Assam since the first outbreaks in 1976 [17, 18]. In Assam, JE cases and deaths have been reported each year after the earliest case recorded in 1978 from the Lakhimpur district [3]. However, a sharp rise was observed in the year 2014. Common signs and symptoms of JE include fever, muscle pain, headaches, abdominal pains with nausea and vomiting, seizures, and often paralysis. Repeated JE cases and deaths have been reported from upper Assam districts, including Dhemaji, Dibrugarh, Golaghat, Jorhat, Lakhimpur, Sibsagar, and Tinsukia. The rural areas are highly prone to JE, with most cases recorded during June to August having heavy rainfall and paddy cultivation. *Culex* sp., breeding predominantly in the paddy fields, are the potential vectors for JE transmission. The disease leaves the patients with lifelong neurological complications. JE virus's life cycle is maintained between potential mosquito vectors and hosts like pigs [19]. Therefore, JE's risk is assessed high among the people inhabiting near paddy fields, water bodies (breeding grounds for JE vectors), and pigs (amplification host) and common among people with low socioeconomic status. Initiatives taken by the state under the National Health Mission to reduce morbidity and mortality due to JE and increase healthcare services include pediatric intensive care units, physical medical rehabilitation departments, strengthening disease surveillance, and recruitment of additional medical professionals [3]. Ecological conditions, rainy summer, agricultural practices, abundant potential vectors and breeding sites, rearing of pigs (amplifying hosts) add to JE's spread in the state. The disease is found in patients of all age groups, but children are the primary target of this fatal disease [18, 19]. To control JE outbreaks, regular malathion fogging is done in the high-risk areas, application of larvivorous fish to control vector breeding, use of insecticide treated nets are also an effective tool to control vector encounter rates. Moreover, health awareness programmes for community action are necessary. Additionally, vaccination campaigns are routinely conducted in the endemic districts [3].

### 2.4 Lymphatic filariasis (LF)

Assam is endemic to Lymphatic filariasis [20]. Although it is endemic in the state, out of 35 districts, the disease has been recorded in only seven districts: Darrang, Dhemaji, Dhubri, Dibrugarh, Kamrup/Kamrup (Metro), Nalbari, and Sibsagar. *Culex quinquefasciatus*, a common household mosquito, is the potential vector of the disease. Their breeding ground constitutes various polluted water bodies such as sewage water collections, open drainage, and ditches closer to human habitations [3]. Both urban and rural areas are prone to filariasis infection [21]. A higher incidence of filariasis is reported from tea garden tribes [3, 22]. The clinical manifestations of the disease include hydrocele and lymphoedema, and elephantiasis is less common. Filariasis is diagnosed by direct demonstration of the parasite *Wuchereria bancrofti* in the patients' blood or skin specimens [21]. The practice involving artificial irrigation in the tea gardens makes

them conducive for vector breeding. Vector density, number of microfilaria carriers, microfilaria density in the carrier, and man-mosquito contact all affect disease transmission [22]. To undertake control measures in endemic areas, National Filaria Control Programme (NFPCP) was launched in India in 1955. Still, a magnified increase in the diseases reflected filariasis control programs' failure [21]. Considerable measures through mass drug administration (MDA) of diethylcarbamazine and albendazole have been undertaken to eliminate lymphatic filariasis [3, 21].

### 3. Conclusion

There is a wealth of evidence that mosquito-borne diseases prevalent in different parts of Assam pose a severe threat to human health and likely to perpetuate. Among the mosquito-borne diseases, malaria, dengue, Japanese encephalitis (JE), and Lymphatic filariasis (LF) are most common in Assam, with malaria and JE being prevalent. Several factors, including the state's favorable tropical climate with heavy rainfall during monsoon and annual floods, provide suitable breeding grounds for most mosquito vectors. Moreover, rapid urbanization, industrialization, and deforestation add to it. Therefore, it is imperative to adopt control measures for these diseases that require knowledge and a better understanding of disease epidemiology for formulating control interventions to check the disease transmission. It is strongly believed that innovative tools and implementation processes, improved surveillance, monitoring and evaluation, judicious application of a combination of technologies, including creating more awareness among the people, and equity in access to healthcare services would help control these diseases. However, it is necessary to conduct further research on the occurrence, transmission and control of mosquito-borne diseases in the state.

### Conflict of interest

The authors declare no conflict of interest.

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