Journal of Communicable Diseases
Volume 57, Issue 3 - 2025, Pg. No. 14-24
Peer Reviewed & Open Access Journal

Research Article

Entomological Surveillance and Risk Assessment for *Aedes*-borne diseases in the Premises of Medical College Campus Institutions in Thiruvananthapuram Municipal Corporation

R Rajendran[1], Kalpana Baruah[2], S B Anusree[3], M S Sasi[4]

[1]Former Joint Director and Consultant, [3]Research Assistant, National Centre for Disease Control, Ministry of Health and Family Welfare, Government of India, Thiruvananthapuram, Kerala, India
[2]Former Additional Director, National Centre for Vector Borne Diseases Control, Ministry of Health and Family Welfare, Government of India, Delhi
[4]Former Assistant Director, Directorate of Health Services, Government of Kerala, India

DOI: https://doi.org/10.24321/0019.5138.202563

I N F O

Corresponding Author:
R Rajendran, National Centre for Disease Control, Ministry of Health and Family Welfare, Government of India, Thiruvananthapuram, Kerala, India
E-mail Id:
rajendran061@gmail.com
Orcid Id:
https://orchid.org/0000-0003-2080-9723
How to cite this article:
Rajendran R, Baruah K, Anusree S B, Sasi M S. Entomological Surveillance and Risk Assessment for *Aedes*-borne diseases in the Premises of Medical College Campus Institutions in Thiruvananthapuram Municipal Corporation. J Commun Dis. 2025;57(3):14-24.

Date of Submission: 2025-06-29
Date of Acceptance: 2025-08-31

A B S T R A C T

Introduction: The escalating public health crises due to *Aedes*-borne diseases (ABDs), such as dengue, chikungunya, and Zika, formidably affect tropical and subtropical regions of the world, including India. Kerala is one of the worst affected states in India, endemic to many vector - borne diseases, particularly *Aedes*-transmitted diseases. In vector prevalence studies, while surveillance is crucial, it's often limited to residential areas, neglecting key public places like hospitals, schools, and other commercial establishments. In hospital premises, the presence of *Aedes* mosquito breeding sites creates a substantial risk of transmitting ABDs to different stakeholders associating with it. This calls for an entomological situation analysis targeting these areas.

Method: Aedes larval field surveillance was conducted in four health facilities in Thiruvananthapuram Municipal Corporation. This involved determining traditional *Aedes* larval indices, as well as pupal index, adult premise index, and breeding preference ratio.

Result: A survey of the Government Medical College campus, encompassing four health facilities and 44 prime premises, indicated the presence of *Aedes* larvae in 8 premises. Significant entomological indices such as Activity area index, pupal index, adult premise index was found out in many of the areas surveyed.

Conclusion: The findings of the study indicate that regular source reduction activities are to be intensified in every hospital and associated institution premises so as to check proliferation of vector mosquitoes and to prevent possible infection of ABDs among different stakeholders associating with these institutions.

Keywords: *Aedes albopictus*, *Aedes* Larval indices, Breeding preference ratio, Hospital settings

Introduction

While reports suggestive of dengue-like illnesses exist as early as 1635 in the West Indies, the first definitively documented and reported dengue fever outbreak occurred concurrently in Asia, North America and Africa in 1779-1780[1,2]. An outbreak of what is believed to be the earliest documented *Aedes (Ae.)* transmitted disease, i.e., yellow fever (YF), occurred in Barbados in 1647[3]. In the next year, Spanish colonists documented a yellow fever (YF) outbreak on the Yucatan Peninsula, where the indigenous Maya referred to the disease as *xekik,* meaning "blood vomit". Brazil experienced its first recorded YF epidemic in Recife in 1685. The term 'yellow fever' itself emerged later, in 1744[4]. Although Carlos Finlay demonstrated in 1881 that YF was transmitted by *Ae. aegypti* (then known as *Culex fasciatus*), his mosquito-borne transmission theory wasn't widely accepted for almost two decades. It wasn't until 1900 that Walter Reed and his colleagues confirmed *Ae. aegypti* as the vector for the YF virus through their extensive research works[6,7].

While the yellow fever virus (YFV) was recognized as early as the 16th century, its isolation in Africa, its native continent, was achieved in 1927 through a collaborative effort involving French researchers from the Pasteur Institute in Dakar and American and English teams from the Rockefeller Foundation. The isolation of the YFV from a Ghanaian patient was a crucial step that paved the way for the development of the first effective YF vaccine in 1937[5]. Early epidemiological understanding strongly considered YFV to spread through a sylvatic cycle in non-human primates involving forest mosquitoes and an urban cycle mediated by mosquitoes residing in urban environments. *Aedes*-borne viral diseases have had a substantial impact on human health throughout history. *Aedes* mosquitoes transmit several critical diseases, including dengue, chikungunya, Zika, and yellow fever.

Yellow fever and dengue fever (DF), both *Aedes*-borne diseases, have significantly impacted human health over time. Investigations into various outbreaks have confirmed *Ae. aegypti* as the primary vector for transmitting these diseases. The incrimination of *Ae. aegypti* mosquitoes as the primary vector of yellow fever and dengue fever prompted investigators to explore tools and methods for assessing the level of *Aedes* mosquito infestation and the potential for disease transmission. Consequently, scientists employed house index (HI), container index (CI), and breteau index (BI) in surveillance activities and outbreak investigations to evaluate *Aedes* mosquito larvae populations and implement effective vector control strategies. The tendency of *Ae. aegypti* mosquitoes to breed near houses makes these indices particularly useful for establishing threshold levels, allowing or the implementation of focused vector control measures in the affected areas. Factors such as rapid urbanization, environmental changes, and climatic variations create increased situations and habitats for the breeding and establishment of *Ae. albopictus* mosquitoes as well as *Ae. aegypti*. While *Ae. aegypti* mosquitoes tend to breed in close proximity to human dwellings, *Ae. albopictus* prefers to breed in diverse environments, such as inside and outside of houses, commercial buildings, unattended open premises, and necessarily all establishments with water-holding structures and sources.

While dengue poses a perennial and major public health challenge in India, scientists are highly apprehensive about a probable yellow fever outbreak, though it has not yet occurred. *Aedes* vector surveillance typically involves randomly selected places or localities, primarily focusing on inspections of residential premises. Surveillance is generally conducted within and in the immediate surroundings of residential properties. Due to rapid urbanisation, a significant number of Kerala villages are in the transitional stage, acquiring urban-level facilities and infrastructure. The proportion of urban population in Kerala has undergone a substantial increase within a decade span of time from 25.96% in 2001 to 47.72% in 2011[8]. If Kerala's urbanisation trend continues, it is highly probable that 96% of the population will reside in urban areas by 2036[9].

Recent entomological studies have highlighted the significant role of *Ae. albopictus* in transmitting diseases like dengue, chikungunya and Zika. Furthermore, high disease prevalence in areas with lower *Ae. aegypti* populations suggests the substantial potential of *Ae. albopictus* in disease transmission[10]. Investigations conducted in Kerala have demonstrated a higher relative prevalence of *Ae. albopictus* in comparison to *Ae. aegypti*[11,12,13]. *Ae. aegypti* exhibits a stronger association with artificial containers within urban environments, while *Ae. albopictus* breeds in both natural and artificial receptacles and is distributed across diverse habitats such as rural, suburban, and urban areas[14].

Strategies to mitigate vector- borne diseases primarily involve entomological surveillance and risk assessment in targeted locations. However, such surveillance/study efforts are often restricted to residential areas, overlooking critical public place locations such as hospitals, schools, and commercial establishments. This oversight is particularly concerning for health care facilities, which are likely to play a significant role in disease outbreaks and rapid community transmission. Within hospital premises, the presence of *Aedes* mosquito breeding sites creates a substantial risk of transmitting *Aedes*-borne diseases to medical and health care personnel, patients, by-standers and visitors. Given the crucial need for monitoring vector mosquitoes in and around health care facilities, this study was designed to be

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202563

carried out in major activity area locations of the Medical College Campus Institutions in Thiruvananthapuram Municipal Corporation, the capital city of Kerala. Within hospital premises, the presence of *Aedes* mosquito breeding sites creates a substantial risk of transmitting *Aedes*-borne diseases to a significantly large number of people of various categories viz. medical and health care personnel, patients, by-standers and visitors. As referral medical institutions, these centers are increasingly vital, catering to the varied healthcare needs of patients from all over Kerala and even outside the state.

Materials and Methods

The study was carried out during 2023-2024, focussing on entomological surveillance and *Aedes*-borne disease risk assessment in the prime activity areas of four Medical College Campus Institutions in Ward No. 16 (Medical College Ward) of Thiruvananthapuram Municipal Corporation.

Study Area

The Thiruvananthapuram Municipal Corporation is geographically positioned at 8^0 3′ North latitude and 76^0 54′ East longitude, encompassing an area of 214.86 sq. km. and extending along a 35 km low-lying coastal region. The target area consists of 1). Govt. Medical College and Nursing College campus, 2.) Tertiary Referral Super Specialty Hospital (Sree Chitra Thirunal Institute for Medical Sciences and Technology (SCTIMST) campus, 3). Cancer Care Hospital and Research Centre (Regional Cancer Centre (RCC) campus and 4). Medical Education Department (Directorate of Medical Education and Research (DMER) campus. The entire campus encompasses 139 -acre (0.56 km^2) of land.

Study Design

The Kerala branch of the National Centre for Disease Control (NCDC) deployed a team, including a senior entomologist, research assistant, and laboratory attendant to conduct vector surveillance in the target areas. The study was designed to assess the dimensions and dynamics of mosquito vector activity in the area, as well as the current extent and severity of vector-borne disease prevalence, specialty of dengue, transmitted by these vectors, and to evaluate the likelihood of an impending vector-borne disease outbreak.

Entomological Surveillance

Typically, an *Aedes* mosquito survey in an institution premise consists of the surrounding area within a 100-meter radius[15]. However, when buildings are situated in close proximity, investigators retain the discretion to determine the appropriate survey area. A thorough examination of the premises of all concerned health facilities was undertaken to identify any goods, materials, or environmental circumstances conducive to mosquito breeding, and also involved direct enumeration of mosquito larvae and pupae to determine their presence and abundance. The study utilized a set of standard and scientifically recognized methods for the calculation of diverse entomological indices[16,17]. Potential mosquito breeding containers include any natural, organic, or artificial material currently harbouring immature mosquitoes (larvae and pupae) or capable of holding water accessible to female mosquitoes for egg-laying. Immatures were collected using appropriate tools like dippers, pipettes, and strainers based on container type[18].

Field- collected larvae and pupae were carefully separated into labelled vials containing relevant details before being transported for examination at the Entomology Laboratory of NCDC, Thiruvananthapuram. An average of 10% of the fourth instar larvae from each container were identified via microscopic examination. The remaining larvae and all pupae were transferred to separate rearing cages and allowed to emerge as adults, which were then identified using standard keys[19]. An examination was conducted of the scattered dry containers on the premises, as these could serve as breeding grounds for *Aedes* mosquitoes during the summer rains or monsoon.

Furthermore, the study sought to establish the pupal index (PI), adult premise index (API), and breeding preference ratio (BPR). The pupal index serves as a key entomological measure for evaluating the adult mosquito population, particularly those species that transmit diseases like dengue. This index is considered a more accurate predictor of adult numbers compared to larval indices. The Adult Premise Index (API) serves as a metric for *Aedes* mosquito population within a defined area. Its calculation involves dividing the total count of *Aedes* mosquitoes identified in premises by the overall number of premises included in the survey. This index is crucial for assessing the extent of *Aedes* infestation and facilitating the development and implementation of targeted vector control interventions.

Breeding Preference Ratio (BPR) measures how much a mosquito favours a specific container or habitat for laying its eggs. For each breeding habitat, we calculated three indices, one for each container grouping category. The index representing available containers (IACs) was determined by dividing the total count of a specific container type within each category by the overall number of containers present on the premises. The index of contribution to breeding sites (ICBSs) represents the proportion of positive containers within each category out of all positive containers on the premises[20]. The BPR was determined by dividing ICBS by IAC for each container type. A BPR value exceeding 1 signifies a stronger preference for that type of container as a breeding site, whereas a value below 1 indicates it is less preferred.

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202563

The study report has been shared to the Director of Health Services (DHS) and the Director of Medical Education (DME), Government of Kerala for appropriate action.

Results

Vector surveillance at Govt. Medical College and Nursing College campus

Activity areas index (AAI) from thirty activity areas, (where consistent human (host) presence is available for vector activity (mosquito bite) and probable transmission of vector-borne diseases (VBDs) such as dengue, chikungunya and Zika), under Medical College Hospital and Nursing College, has been calculated. Breeding was identified in 5 of these areas, contributing to an AAI of 16.66%. A significant majority (90.46%) of water- holding containers/ sources on the MCH campus were located in the kitchen area (Table 1).

In addition, 13 out of the 723 water-holding containers/ sources examined were positive for *Aedes* larvae, yielding a Container Index (CI) of 1.79%.

Out of the 723 water-holding containers/sources examined, eggshells constituted the vast majority at 77.73%. Following this were plastic (5.12%), metal (4.01%), glass bottles (3.60%), earthen items (3.46%), thermocol (2.77%), and other less frequent types (Table 2). Notably, over 90% of these water-holding sources were located within kitchen areas. The daily use of more than a thousand eggs in hostel kitchens and the general canteen supports the observation of numerous empty eggshells mixed with vegetable waste in the kitchen backyard. Despite the prevalence of water-filled eggshells, none were found to contain *Aedes* larvae. If eggshells are not disposed of promptly, they could become potential breeding sites for *Aedes* mosquitoes, thereby increasing the risk of disease outbreaks.

Tyres accounted for the largest proportion (38.46%) of *Aedes*-positive breeding sources identified on the premises (Table 3). Thermocol was the next most common (23.08%), followed by metal (15.38%), and fridge or cooler components (7.70%). The frequent arrival of valuable equipment packaged in thermocol at the medical college results in thermocol pieces being discarded in various locations around the premises. Without proper disposal mechanisms, these scattered and non-degradable thermocol remnants are likely to become potential breeding grounds for Aedes mosquitoes during the rainy season.

Vector surveillance at Tertiary Referral Super speciality -Hospital Campus

Aedes breeding was detected in only one of the five activity areas inspected (Table 3). The two metal containers observed in Sree Chitra Thirunal Park were both found to harbour *Aedes* larvae. Based on the surveillance data, the activity areas index (AAI) and container index (CI) were calculated as 20% and 100% respectively.

Table 1.Surveillance of *Aedes* mosquitoes at different premises of Medical college campus

Sl. No.	Activity areas searched	Water holding containers	
		Checked	Positive
1	Medical College Casualty	-	-
2	Medical College OP Block	-	-
3	SAT OP Block	-	-
4	SAT Casualty	-	-
5	Ladies hostel UG	12	1
6	Ladies hostel Backyard	4	-
7	Kitchen area	654	-
8	Hostel PG	-	-
9	Child Development Centre	-	-
10	SAT OP Parking area	-	-
11	Dept. of Physical Education	2	-
12	Dept. of Pathology		
13	Dept. of Biomedical Engineering	-	-
14	College of Pharmaceutical Sciences	2	-
15	Microbiology Lab	1	-
16	Dr. Karunakar Memorial Hall	8	2
17	Priyadarshini Institute of Paramedical Science Hostel	-	-

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202563

18	Multidisciplinary Research Unit	3	-
19	Research Lab	-	-
20	New Hostel	8	5
21	Animal House	10	-
22	Physical Medicine and Rehabilitation	-	-
23	Medical College Library	-	-
24	Medical College Credit Society	12	3
25	Canteen	4	2
26	Office of the Principal	-	-
Nursing College			
27	Office	-	-
28	PG Block	1	-
29	Hostel	1	-
30	Kitchen	1	-
Total		723	13

Table 2.Breeding sources of *Aedes* mosquitoes in medical and Nursing College Campus, Thiruvananthapuram

Sl. No.	Type of containers/sources	Checked	Positive
1	Plastic/ Leather	37	1
2	Metal	29	2
3	Earthen	25	0
4	Glass bottles	26	0
5	Thermocol	20	3
6	Coconut shells	12	0
7	Egg shells	562	0
8	Tires	8	5
9	Cement tank	1	0
10	Fridge/Cooler	03	02
Total		723	13

Table 3.Surveillance of *Aedes* mosquitoes at different activity areas of Tertiary Referral Super speciality Hospital, Thiruvananthapuram

Sl. No.	Activity areas searched	Water-holding containers	
		Checked	Positive
1	Dept. of Cardiology	-	-
2	Cardiology OP	-	-
3	Sree Chitra Thirunal Park	2	2
4	Neurology OP	-	-
5	Achutha Menon Centre for Health Sciences Studies	-	-
Total		2	2

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202563

Vector surveillance at Cancer Care Hospital and Research Centre

Out of the four activity areas at the Regional Cancer Centre (RCC) inspected for *Aedes* larvae, only one location i.e. the D Block Drivers Room showed evidence of mosquito breeding. Specifically, one of the three tyres stored outside the drivers' room contained *Aedes* larvae (Table 4). The current investigation at the RCC premises revealed the following indices for *Aedes* larvae: a premise index of 25% and a container index of 20% respectively.

Vector surveillance at the Office of the Medical Education Department campus

An entomological survey at five activity areas of the Medical Education Department revealed the presence of *Aedes* larvae in only one location. Specifically, three out of five water-filled, unused tyres discarded on those premises contained *Aedes* larvae (Table 5). No other water-holding containers in any of the other premises were found to harbour mosquito larvae. The activity areas index and container index were found to be 20% and 60% respectively.

Aedes larval indices within the Medical College campus indicated that the activity area index ranged from 16.66% to 25% across different health facilities (Table 6).

Our investigation of emerged adult mosquitoes and wild-caught specimens from the specified hospitals and health facilities revealed only the presence of *Ae. albopictus*. Notably, no *Ae. aegypti* larvae or pupae were found in any of the containers in the areas surveyed.

The MED campus exhibited a higher Adult Premise Index (API) and greater number of female *Ae. albopictus* per positive premise compared to other health facilities. We found no adult *Aedes* mosquitoes on the TRSSH premises (Table 7).

The current entomological investigation on the Govt. Medical College campus revealed the highest pupal index (4.00 pupae/positive container) in plastic and leather containers, followed by metal containers (2.25), tyres (1.89), and thermocol packs (1.33). The study also revealed that, *Ae. albopictus* preferred to breed in fridges/coolers (25.68), followed by tyres (21.73), thermocol (5.81), metal (4.99), and plastic/leather (1.05) (Table 8).

Table 4.Surveillance of *Aedes* mosquitoes at different activity areas of Cancer Care Hospital and Research Centre, Thiruvananthapuram

Sl. No.	Activity areas searched	Water-holding containers	
		Checked	Positive
1	Block C	-	-
2	Block D	-	-
3	Divers Room- D Block	5	1
4	Radiation Room	-	-
Total		5	1

Table 5.Surveillance of *Aedes* mosquitoes at different activity areas of the Medical Education Department, Thiruvananthapuram

Sl. No.	Activity areas searched	Water-holding containers	
		Checked	Positive
1	Old building	-	-
2	DME office	-	-
3	Backside Shed	5	3
4	Building I	-	-
5	Building II	-	-
Total		5	3

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202563

Table 6.Summary of traditional *Aedes* larval indices and distribution of *Aedes* mosquito breeding habitats at different health facilities and activity areas in Govt. Medical College Campus, Thiruvananthapuram

Health facilities	No. of Activity areas searched	No. of Activity areas positive	No. of containers checked	Containers positive	AAI (%)	CI (%)
MCH & NC	30	05	723	13	16.66	1.79
TRSSH		01	02	02	20	100
CCH &RC	04	01	05	01	25	20
MED	05	01	05	03	20	60
Total	44	08	735	19	18.18	2.59

MCH & NC – Medical College Hospital & Nursing College, TRSSH- Tertiary Referral Super Speciality Hospital, CCH &RC – Cancer Care Hospital and Research Centre, MED – Medical Education Department

Table 7.Adult Premise Index (API) pertaining to different hospital premises

Health facilities	Activity areas searched	Activity areas positive	Females collected	Adult Premise Index (API)	Female/ premise	Female/ positive premise
MCH & NC	30	03	06	10	0.2	2.0
TRSSH	05	Nil	Nil	Nil	Nil	Nil
CCH&RC	04	01	02	2.5	0.5	2.0
MED	05	01	03	20	0.6	3.0

MCH & NC – Medical College Hospital & Nursing College, TRSSH- Tertiary Referral Super Specialty Hospital, CCH &RC – Cancer Care Hospital and Research Centre, MED – Medical Education Department

Table 8.Preferred breeding habitats of *Ae. albopictus* in the entire Medical College campus

Sl. No.	Breeding Sources	Examined	Positive for Aedes immature	No. of pupae collected	Pupae/positive container	BPR
1	Plastic/Leather	37 (5.03)	1 (5.26)	4	4.00	1.05
2	Metal	31 (4.22)	4 (21.05)	9	2.25	4.99
3	Earthen/Ceramics	25 (3.40)	0	0	0.00	0.00
4	Glass bottles	27 (3.67)	0	0	0.00	0.00
5	Thermocol	20 (2.72)	3 (15.79)	4	1.33	5.81
6	Coconut shells	12 (16.33)	0	0	0.00	0.00
7	Egg shells	562 (76.46)	0	0	0.00	0.00
8	Tires	16 (2.18)	9 (47.37)	17	1.89	21.73
9	Cement tank	1 (0.14)	0	0	0.00	0.00
10	Fridge/cooler	3 (0.41)	2 (10.53)	0	0.00	25.68
11	Roof gutter	1 (0.14)	0	0	0.00	0.00

BPR – Breeding Preference Ratio

Discussion

Aedes mosquitoes transmit several viral diseases of public health significance, including dengue, chikungunya, Zika, and yellow fever. Dengue and chikungunya are major concerns with widespread prevalence in India. Zika virus (ZIKV) has recently been detected in a few states, but yellow fever (YF) has not yet been reported in India. Of these, dengue fever (DF) is the fastest-spreading arboviral infection, characterized by its evolving epidemiology and potentially severe outcomes. Globally, nearly half of the world's population resides in dengue-endemic countries.

For decades, Kerala has grappled with significant public health challenges caused by recurring outbreaks of *Aedes* borne diseases like dengue and chikungunya. These outbreaks have led to substantial life losses, depleted resources and placed immense strain on the healthcare system. The recent report of the Zika virus has intensified this already precarious situation.

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202563

The proliferation of *Aedes* mosquitoes, driven by factors such as unplanned urbanisation, construction activities, population movement, improper solid waste management and socio-ecological conditions, has led to the spread of dengue, chikungunya, and Zika across the country in the last three decades. Vector breeding in and around hospital facilities significantly increases the transmission risk of *Aedes* borne viral diseases for healthcare workers, patients, visitors, and on-campus residents and students[21].

Ae. aegypti is the main vector of these diseases across the country. However, in the plantation rich regions of peninsular and northeastern states, *Ae. albopictus* plays a more significant role in transmission. The lush vegetation characteristic of southern Indian states like Kerala, situated within the peninsular region, creates an environment where *Ae. albopictus* could readily serve as the main vector for dengue and other *Aedes*-transmitted diseases in the area.

As a vital component of vector-borne disease control, entomological surveillance generates essential data and information that guides vector control programmes and facilitates early warning and epidemic prediction. Vector surveillance in public settings such as hospitals and educational institutions plays a significant role in evaluating the diversity and magnitude of vector breeding sources. This knowledge is critical for adopting the most suitable vector control strategies and thereby averting impending outbreaks of *Aedes*-borne diseases.

Aedes larval indices like HI and CI were formed when *Ae. aegypti* was the dominant vector in most disease affected areas. Over the past two decades, numerous researchers have highlighted the role of *Ae. albopictus* in disease transmission, particularly in areas where *Ae. aegypti* populations are low or absent[22,23,24,25]. A comprehensive examination of the bionomics of *Ae. albopictus* is essential, considering the changing distribution of mosquito vectors. This should include a detailed analysis of their breeding habitats, oviposition preferences, resting habits, and capacity to transmit diseases. Therefore, it is crucial to evaluate whether the standard methodologies employed by entomologists are sufficient to accurately assess the transmission intensity of *Aedes*-borne diseases, particularly in regions where *Ae. albopictus* is the dominant species.

Traditional *Aedes* vector surveillance typically focusses on residential areas and their immediate surroundings. However, the establishment of *Ae. albopictus* in diverse non-residential settings, such as commercial buildings, educational institutions, hospitals, places of worship, restaurants, and public parks, provides expanded breeding opportunities for this mosquito species.

Given the daytime biting behaviour of *Aedes* mosquitoes, the risk of disease transmission is high in environments where breeding sites are not regularly eliminated. The monsoon and post-monsoon seasons in Kerala witness a rise in *Aedes*-borne diseases, fuelled by extensive breeding habitats regardless of location. This upward trend has been evident in vector-borne disease reports over the last twenty-five years. Critically, if *Aedes* breeding habitats are unchecked within hospital environments where infected individuals arrive seeking medical care, the potential for disease spread through vector mosquito bites is quite high. Consequently, proactive vector surveillance at hospitals and health facilities is essential for disease containment. This study elucidates the importance of vector surveillance at activity areas of hospitals and other medical institutions to assess environmental factors supporting *Aedes* mosquito breeding.

As *Aedes* larval *i*ndices, Premise Index (PI) and Container Index (CI) serve as direct measures of mosquito breeding intensity and indirect measures of mosquito population density within an area. Pupal index (Pl. I) is a more accurate measure of adult mosquito abundance, whereas Adult premise Index (API) directly reflects the density of adult female mosquitoes, the primary disease transmitters[26].

Initially, the *Aedes* larval indices were developed for YF prevention and risk prediction, and no specific thresholds have been established for dengue transmission[27]. However, due to the similar ways dengue and yellow fever viruses spread, a Premise index of 1% or lower, or a Breteau index of five or lower, has been suggested as a target to prevent dengue transmission[27]. The Pan American Health Organization (PAHO) has established a three -tiered system for dengue transmission risk factors: low indicated by a PI < 0.1%), medium (0.1% to < 5%), and high (PI >5%) [29]. The observed AAI and BI values in all surveyed hospital environments were above the established threshold. Therefore, immediate action is required to implement source reduction activities in all hospital premises, with the technical assistance and involvement of hospital management authorities, medical personnel, the local self-government institution and the concerned public. It has come to light that The Thiruvananthapuram Medical College authority has not adhered to the National Centre for Vector-borne Diseases Control (NCVBDC) guidelines that necessitate the establishment of a vector control unit provided with a nodal officer for monitoring vector control activities[21].

The Adult Premise Index (API) analysis demonstrated that DME premises had the highest value, with medical and nursing college premises showing lower values in that order. While pupal indices are indeed crucial for keeping tabs on dengue risk, the fact that researchers use so many different calculations-like the traditional pupal index (PI), pupal household index (PHI), pupae per person (PPP), and

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202563

pupae per positive container (PPC)- highlights a real need to understand how these different measures stack up against each other. We need to figure out which index, or perhaps a combination of them, gives us the most reliable picture of potential *Aedes*-borne disease outbreaks across various geographical settings. The same scrutiny should absolutely be applied to the Adult Premise Index (API) as well. Despite representing a small fraction of the containers surveyed (0.41% for fridges/coolers) and 2.18% for tyres out of 735 total), these receptacles exhibited a higher Breeding Preference Ratio (BPR) compared to others. Notably, even though eggshells were the most abundant container type (over 76%), they yielded no *Aedes* larvae. This suggests a strong ovipositional preference by *Ae. albopictus* for fridges/coolers and tyres. It is crucial to exercise caution when interpreting BPR data from container types found in low numbers. However, our extensive field observations corroborate this apparent preference for these specific artificial containers as breeding sites.

Unfortunately, hospitals sometimes provide environments conducive to mosquito breeding. Due to the large and diverse category of visitors and the possible presence of mosquito breeding habitats, hospitals tend to provide vulnerable settings for the transmission of *Aedes*-borne diseases like dengue, chikungunya, and Zika. This underscores the necessity of entomological surveillance at these facilities with a view to generating sufficient data and information required for adopting strategies for mosquito breeding habitats elimination, forestalling VBDs, and protecting patients, staff, bystanders, and visitors from vector-borne diseases infection and thus ensuring a safe hospital environment.

The present survey regarding emerged adult mosquitoes and wild-caught specimens from the specified hospitals and health facilities revealed only the presence of *Aedes albopictus*. Notably, no *Ae. aegypti* larvae or pupae were found in any of the containers in the area surveyed. Entomological surveillance at five Philippine public hospitals treating dengue patients found that *Ae. aegypti* was the only mosquito species present. This species primarily bred in fresh water containers such as plant vases, drums, basins, plastic cups, tin cans, and empty paint cans[29]. A study on effective *Ae. aegypti* vector surveillance in a Cuiaba, Mato Grosso, Brazil, hospital setting highlighted that hospitals can be significant sites for dengue transmission. Therefore, these locations should be prioritise as strategic areas in dengue control programs focused on preventing transmission[31].

In India, there are very few published studies, detailing entomological surveillance in hospital settings. Consequently, research on vector prevalence near hospital facilities is critically important to prevent disease outbreaks. A comprehensive entomological survey conducted in Delhi in 1998, encompassing a range of sites such as the Municipal Corporation of Delhi (MCD), the New Delhi Municipal Corporation (NMC), Railway premises, the Delhi Cantonment, and numerous hospitals and schools, documented the presence of *Ae. aegypti* breeding[32]. A study on the seasonal changes in *Ae. aegypti* populations across different areas of Delhi found water coolers and tires as the most preferred breeding sites for these mosquitoes[33]. Similarly, the present investigation also identified refrigerators/coolers and tires as the most favoured breeding habitats for *Ae. albopictus* mosquitoes within hospital environments.

A recent study examining mosquito density and larval indices on a rural hospital campus in Thrissur district, Kerala, found that discarded plastic containers were the primary breeding site for *Ae. albopictus* mosquitoes[34]. Effective dengue prevention necessitates a multi-pronged strategy focused on source reduction. This encompasses rigorous plastic waste control, consistent clearing of water-holding containers, and comprehensive health education to foster community understanding and engagement in eliminating mosquito breeding sites.

Conclusion

The present study in Thiruvananthapuram Municipal Corporation revealed a high prevalence of *Aedes* mosquito larvae in hospitals, with premise indices exceeding safe levels in all four medical institution campuses. The presence of female *Ae. albopictus* mosquitoes in the area further adds to the risk of VBD outbreaks. This calls for immediate action to prevent and control the presence and proliferation of vector mosquitoes within hospital environments. Recommended measures include personal protection strategies, environmental modifications to eliminate breeding sites, effective operation of vector control units in major hospitals, effective Information, Education, and Communication/ Behaviour Change Communication (IEC/ BCC) and public awareness activities involving hospital management authorities, medical personnel, the local self-government institution and the concerned public. It is recommended that the Thiruvananthapuram medical college authority immediately take steps to establish a vector control unit, along with a designated nodal officer to monitor vector control programmes and activities within the medical college campus, preferably in liaison with the local self-government i.e., Thiruvananthapuram Municipal Corporation.

Acknowledgement: We extend our sincere gratitude to the Director of the National Centre for Disease Control for his valuable support. We also thank Shri. K B Gopalakrishnan, Lab Attendant at the National Centre

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202563

for Disease Control (NCDC), Thiruvananthapuram, for his support in the entomological surveillance activities.

Authors' Contribution: RR- Conceptualisation and wrote original draft, KB - Reviewed the manuscript, SBA- Data Analysis, MSS- Assisted in draughting.

Conflict of Interest: None

Source of Funding: None

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process: None

References

1. Hirsch A. Handbook of geographical and historical pathology. New Sydenham Society; 1883. [Google Scholar]
2. Gubler DJ. Dengue and dengue hemorrhagic fever. Clinical microbiology reviews. 1998 Jul 1;11(3):480-96. [Google Scholar]
3. McNeill JR. Yellow jack and geopolitics: environment, epidemics, and the struggles for empire in the American tropics, 1650–1825. OAH Magazine of History. 2004 Apr 1;18(3):9-13. [Google Scholar]
4. Mitchell, J. Mitchell's account of the yellow fever in Virginia in 1741-2, 1805, Archived on 23.02.2023 at the way back Machine [Internet]. The Philadelphia Medical Museum, 1(1): 1-20. Accessed on 3 April, 2025.
5. Rodhain F. Yellow fever: A brief history of a tropical Virosis. La Presse Medicale. 2022 Sep 1;51(3):104132. [Google Scholar]
6. Reed W, Carroll J, Agramonte A. Experimental yellow fever. Trans Assoc Am Physicians. 1901;16:45-70. [Google Scholar]
7. Gabiane G, Yen PS, Failloux AB. Aedes mosquitoes in the emerging threat of urban yellow fever transmission. Reviews in Medical Virology. 2022 Jul;32(4):e2333. [Google Scholar]
8. Urbanization in Kerala- Economic Review, 2016 [Internet]. State Planning Board. https://spb.kerala.gov.in . Accessed on 2 April, 2025.
9. Urbanization in Kerala- Economic Review, 2024 [Internet]. State Planning Board. https://spb.kerala.gov.in . Accessed on 2 April, 2025.
10. Sasi MS, Rajendran R, Meenakshy V, Suresh T, Heera Pillai R, Dilip Kumar T, Sugathan A, Regu K. Study on vector dynamics of zika virus outbreak in thiruvananthapuram, Kerala, India. Int J Curr Microbiol App Sci. 2021;10:54-71. [Google Scholar]
11. Vijayakumar K, Kumar TS, Nujum ZT, Umarul F, Kuriakose A. A study on container breeding mosquitoes with special reference to Aedes (Stegomyia) aegypti and Aedes albopictus in Thiruvananthapuram district, India. Journal of vector borne diseases. 2014 Jan 1;51(1):27-32. [Google Scholar]
12. Vaz C, Harikumar A, Mundodan JM, Rafi M, Saju CR. Mosquito density in rural Kerala: a study on the trend of Aedes larval indices over monsoon in a rural area of Thrissur district, India. International Journal of Community Medicine and Public Health. 2019 Oct;6(10):4528-32. [Google Scholar]
13. Rajendran R, Regu K, Anusree SB, Tamizharasu W, Rajendran A. Surveillance of Aedes (Stegomyia) mosquitoes in and around International Airport, Kerala-Assessment of vector control efforts. Entomon. 2020 Jun 30;45(2):135-42. [Google Scholar]
14. Rajendran R, Anusree SB, Regu K. Seasonal variation and breeding preference of Aedes albopictus in one of the coastal districts of Kerala. [Google Scholar]
15. Troyo A, Fuller DO, Calderón-Arguedas O, Beier JC. A geographical sampling method for surveys of mosquito larvae in an urban area using high-resolution satellite imagery. Journal of vector ecology: journal of the Society for Vector Ecology. 2008 Jun;33(1):1. [Google Scholar]
16. WHO W. Epidemiological situation'. WHO. World Health Organization. 2016. [Google Scholar]
17. World Health Organization. Framework for national surveillance and control plans for Aedes vectors in the Pacific. In Framework for national surveillance and control plans for Aedes vectors in the Pacific 2023. [Google Scholar]
18. National Vector Borne Diseases Control Program (NVBDCP). Compendium on Entomological Surveillance & Vector Control in India. 2016.[Internet]. DGHS, Ministry of Health and Family Welfare, Govt. of India. https://nvbdcp.gov.in . Accessed on 16 April, 2025.
19. World Health Organization. Pictorial identification key of important disease vectors in the WHO South-East Asia Region. In Pictorial identification key of important disease vectors in the WHO South-East Asia Region 2020. [Google Scholar]
20. Garjito TA, Hidajat MC, Kinansi RR, Setyaningsih R, Anggraeni YM, Mujiyanto, Trapsilowati W, Jastal, Ristiyanto, Satoto TB, Gavotte L. Stegomyia indices and risk of dengue transmission: a lack of correlation. Frontiers in Public Health. 2020 Jul 24;8:328. [Google Scholar]
21. National Centre foe Vector Borne Diseases Control (NCVBDC). Operational Guidelines for Prevention and Control of *Aedes* mosquitoes in Hospital settings. DGHS, Ministry of Health and Family Welfare, Govt. of India, 2022; 1-10 pp. [Internet]. https://ncvbdc.mohfw.gov.in . Accessed on May 9, 2025.
22. Thenmozhi V, Hiriyan JG, Tewari SC, Samuel PP, Paramasivan R, Rajendran R, Mani TR, Tyagi BK. Natural vertical transmission of dengue virus in Aedes albopictus (Diptera: Culicidae) in Kerala, a southern

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202563

Indian state. Japanese Journal of Infectious Diseases. 2007 Sep 27;60(5):245-9. [Google Scholar]
23. Das BP, Kabilan L, Sharma SN, Lal S, Regu K, Saxena VK. Detection of Dengue Virus in Wild Caught Aedes albopictus (Skuse) around Kozhikode Airport, Malappuram District, Kerala, India. [Google Scholar}
24. Niyas KP, Abraham R, Unnikrishnan RN, Mathew T, Nair S, Manakkadan A, Issac A, Sreekumar E. Molecular characterization of Chikungunya virus isolates from clinical samples and adult Aedes albopictus mosquitoes emerged from larvae from Kerala, South India. Virology Journal. 2010 Aug 13;7(1):189. [Google Scholar]
25. Paulraj PS, Leo SV, Govindarajan R, Babu RS, Nagaraj J, Dilip Kumar DK, Arunachalam N. Anthropophilic behavior of Aedes albopictus: a predominant vector of dengue/chikungunya in Thiruvananthapuram district, Kerala, South India. [Google Scholar]
26. Wai KT, Arunachalam N, Tana S, Espino F, Kittayapong P, Abeyewickreme W, Hapangama D, Tyagi BK, Htun PT, Koyadun S, Kroeger A. Estimating dengue vector abundance in the wet and dry season: implications for targeted vector control in urban and peri-urban Asia. Pathogens and global health. 2012 Dec 1;106(8):436-45. [Google Scholar]
27. World Health Organization, Special Programme for Research, Training in Tropical Diseases, World Health Organization. Department of Control of Neglected Tropical Diseases, World Health Organization. Epidemic, Pandemic Alert. Dengue: guidelines for diagnosis, treatment, prevention and control. World Health Organization; 2009. [Google Scholar]
28. Sanchez L, Vanlerberghe V, Alfonso L, del Carmen Marquetti M, Guzman MG, Bisset J, Van Der Stuyft P. Aedes aegypti larval indices and risk for dengue epidemics. Emerging infectious diseases. 2006 May;12(5):800. [Google Scholar]
29. Pan American Sanitary Bureau. Dengue and dengue hemorrhagic fever in the Americas: guidelines for prevention and control. Pan American Health Organization; 1994. [Google Scholar]
30. Cruz EI, Salazar FV, Aure WE, Torres EP. Aedes survey of selected public hospitals admitting dengue patients in Metro Manila, Philippines. [Google Scholar]
31. Leal-Santos FA, de Arruda Santana MB, de Figueiredo DA, de Oliveira MM, Acel AM, Ribeiro AL, Rodrigues JS, Carvalho-Leandro D, Miyazaki RD, Leite-Jr DP. Effective surveillance of vector dynamics of Aedes aegypti in a hospital setting in Cuiabá, Mato Grosso, Brazil. The Journal of Infection in Developing Countries. 2014 Oct 15;8(10):1356-60. [Google Schola]
32. Sharma RS, Panigrahi N, Kaul SM. Aedes aegypti prevalence in hospitals and schools, the priority sites for DHF transmission in Delhi, India. [Google Scholar]
33. Sharma RS, Kaul SM, Sokhay J. Seasonal fluctuations of dengue fever vector, Aedes aegypti (Diptera: Culicidae) in Delhi, India. Southeast Asian J Trop Med Public Health. 2005 Jan 1;36(1):186-90. [Google Scholar]
34. Nithya, M.C, Sruthi, M.V, Saju, C.R, Rafi, M.M. A study on Mosquito Density and Trend of Larval Indices from a Hospital Campus of Rural Area, Thrissur District, Kerala. International Journal of Multidisciplinary Research and Analysis. 2022, 5(7):1620-1625. [Google Scholar]. Accessed on May 11, 2025.

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202563