

Original Research Article

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## Entomological Surveillance of Vectors of Yellow Fever, Dengue, Chikungunya and Zika Virus at Kannur International Airport, Kerala, India

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### ABSTRACT

*Aedes*-borne diseases such as dengue, chikungunya, yellow fever, Zika virus, etc. are growing global concern due to geographic expansion of vectors and pathogens. The International Health Regulations (IHR) envisage that every international ports/airports and its adjacent areas within a perimeter of 400 meters should be kept free from *Aedes* mosquitoes. Kannur International Airport was opened on September 2018. Some minor construction work is in progress. In order to assess the existing situation on the prevalence and distribution of *Aedes* (*Stegomyia*) mosquitoes and control measures taken thereof, a vector survey was carried out in and around Kannur International Airport in the month of May 2019 (Pre monsoon) by National Centre for Disease Control, Calicut, Kerala branch. This is the first Entomological surveillance inside the airport since its inception. In order to find out the fluctuation of *Aedes* larval indices, the survey was done in November 2019 (Post monsoon) in and around the airport area. The premise index (PI) was found to be above the critical level inside the airport in both the seasons. During post monsoon, the Breteau index (BI) was found above the critical level inside the airport. However, all the *Aedes* larval indices were found below the critical level in the residential areas around the airport in both the seasons.

#### Keywords

*Aedes*-borne diseases;  
Entomological surveillance;  
Vector control

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### Introduction

Vector-borne diseases (VBDs) are among the most important global public health problems and are associated with serious economic burden in affected countries. VBDs occur mostly in tropical and subtropical regions and

are transmitted by hematophagous arthropods and most importantly by mosquitoes. The emergence and re-emergence of VBDs during the past 50 years have been steered by population growth, unplanned urbanization, globalization, expanded conveyance facilities, etc. (WHO, 2020).

Among the VBDs, Mosquito-borne diseases (MBDs) play a significant role in human sufferings all over the world. It is estimated that nearly 700 million people get a mosquito-borne infection resulting in over 1 million deaths annually (Caraballo and King, 2014). Mosquitoes belong to the family Culicidae and currently it includes 3,585 species (Harbach,2021), of which *Aedes (Stegomyia)* mosquitoes are medically important as they transmit diseases such as yellow fever (YF), dengue (DF), chikungunya (CHIK), Zika virus, etc.

Among the *Aedes (Stegomyia)* mosquitoes, *Aedes aegypti* and *Aedes albopictus* are two most common mosquito species across the world. This is mainly due to their capability to adapt to new environments and is capable of transmitting viruses to humans. *Ae. aegypti* is known to transmit viruses such as dengue, yellow fever, chikungunya and Zika.

It is considered to be a potential vector of Venezuelan Equine Encephalitis (Larsen and Ashley, 1971), and is capable of transmitting West Nile virus also (Truell, *et al.*, 2005). *Ae. aegypti* proliferates in densely populated areas which lack proper water supply, waste disposal and sanitation, etc. (Honorio *et al.*, 2009). *Ae.albopictus* is also playing a role as vector for the transmission of YF, DF, CHIK fever (Hochedez *et al.*, 2006) and Usutu virus (Calzolari *et al.*, 2012). *Aedes* mosquito is considered as a highly domesticated mosquito, very adapted to living with man, preferring to rest indoors and to feed on humans during day time. The *Aedes* mosquitoes generally breed in man-made and natural habitats seen in house/building premises (Sheela Devi *et al.*, 2012; Rajendran *et al.*, 2019a; Rajendran *et al.*, 2020a; Rajendran *et al.*, 2021a).

Dengue is one of the most prevalent viral infections transmitted by *Aedes* mosquitoes. Dengue fever (DF) has become a major public

health concern in many parts of the world including India. Chikungunya fever (CHIKF) is a global public health concern and is caused by chikungunya virus (CHIKV).India witnessed major CHIKF outbreaks from 2005-2010.

After 2010, the country experienced a drastic decline in reported cases (Muniaraj, 2014). Zika, another *Aedes*-borne viral disease is reported from Gujarat, Tamil Nadu and recently from Rajasthan (Yadav *et al.*, 2019).

Though most of the countries in Asia have favorable conditions for *Aedes* mosquito breeding and considered receptive for yellow fever (YF) transmission, the disease has never occurred in Asia. But the possibility of transmission of YF in Asia cannot be impeded, especially considering the rapid ingress of travelers from endemic areas (Agampodt and Wickramage, 2013).

The rapid global development of conveyance facilities accelerated the entry and establishment of *Ae.aegypti* and *Ae.albopictus* in seaports and airports and thus there exist a potential threat of disease outbreaks. To tackle the threat of global spread of vectors and VBDs and to sustain sanitary standards at international borders and points of entry (PoE), the fifty-eight World Health Assembly adopted the new International Health Regulations-IHR(WHO, 2008). The IHR anticipate that all International seaports and airports should be kept free from all types of vector mosquitoes for a distance of 400 meters around the perimeter of the ports to attain the utmost aim of public health safety. To achieve this, regular vector surveillance and suitable vector control measures should be carried out in and around the ports. Present finding recites to an assessment carried out in Kannore airport during third week of May 2019 (Pre monsoon) and last week of November 2009 (Post monsoon).

## Materials and Methods

### Study area

Vector surveillance was carried out in around Kannur International Airport. It is located near Mattannur municipality in Thalassery taluk of Kannur district, Kerala state. It was opened on 9<sup>th</sup> September 2018 and is operated by Kannur International Airport Limited (KIAL), a public-private partnership trust. The coordinates of the airport are 11.92° North and 75.55° East. This airport is having an area of about 2,300 acres. The airport has an integrated passenger terminal with a floor area of 97,000m<sup>2</sup>, for both International and domestic travelers. The airport has one runway, 07/25 which is 3,050 by 45 meters. The airport has aircraft maintenance, repair and overhaul unit facility and is expected to cater to both narrow and wide bodied aircrafts. The other facilities include aviation fuel farm, Indian Navy air enclave, cargo terminal complex, etc. To assess the *Aedes* mosquito prevalence around the airport, 100 houses were randomly selected from Mattannur municipal and Kizhellarpanchayath areas.

### Entomological surveillance

*Aedes* surveillance was undertaken in and around Kannur International Airport during the third week of May 2019 (Pre monsoon) and last week of November 2019 (Post monsoon). Kannur airport was opened on September 2018. The Vector surveillance carried out by NCDC, Kerala branch in KIAL in May 2019 is the first of its kind since its launch. Entomological surveillance of *Aedes* mosquito has been standardized on different larval indices on the simple confirmation of the presence or absence of *Aedes* immature in each container seen in and around each house (Nagpal *et al.*, 2016). All water holding containers seen inside the house/building (such as water stored utensils, coolers,

refrigerator trays, fire extinguisher buckets, overhead tanks, cement tanks attached to bath rooms, etc.) and containers/habitats seen around the house (namely, plastic, metal, earthen containers; cement tanks, glass bottles, coconut shells, discarded tires, etc.) were inspected. The collected larvae were identified microscopically/after adult emergence as per guidelines (WHO, 1995).

The number of premises/houses surveyed and positive for *Aedes* larvae, number of containers searched and positive/house or premise was recorded in a pre designed proforma for classification. The usual methods of *Aedes* survey as adopted by the National Vector Borne Disease Control Program (NVBDCP) for outbreak investigations were adopted. The data on larval survey were analyzed and calculated in terms of house index/premise index (HI/PI- percentage of houses/premises positive for *Aedes* larvae), container index (CI-percentage of containers positive for larvae), number of positive containers per 100 houses - Breteau Index (BI).

## Results and Discussion

### Kannur International Airport

In operational areas of Kannur airport, a total of 14 water holding containers at 17 premises were checked in May 2019 (Pre monsoon), in which 2 containers were found positive for *Aedes* larvae (PI-11.76%). The details are given in Table 1. Of the 14 containers searched, 71.43% were plastic containers followed by earthen (21.43%) and metal containers (7.14%) Among these, 2 containers were found positive for *Aedes* larvae (CI-14.28%) and breteau index was found to be 11.76 (Fig. 1).

In order to find out the seasonal variation of *Aedes* larval indices inside the airport, survey

was done in November 2019 (Post monsoon). Of the 17 premises checked, 2 were found positive for *Aedes* breeding (PI- 11.76%). A total of 35 water holding containers were examined, 4 were found positive for *Aedes* immatures (CI-11.42%) and the breteau index was 23.53 (Fig.1). Of the total containers checked, 45.71% were discarded tires followed by plastic (31.43%), metal (22.86%) containers. Of the 4 *Aedes* positive containers, plastic and metal containers constitute 50% each.

### **Residential area**

Pre monsoon *Aedes* surveillance in the residential areas around airport was done in 100 randomly selected houses. Inside and the surroundings of each house was closely examined for *Aedes* mosquito breeding, but only 4 premises were found positive for *Aedes* larvae/pupae (HI-4%). A total of 35 water holding containers were seen in the survey area. Among these, 54.29% were plastic containers followed by discarded tires (20%), metal (17.14%) and cement tanks (8.57%). The details are given in Table 2. Of these, 4 containers were found positive for *Aedes* breeding (CI-11.4%) and the breteau index was 4 (Fig.2).

*Aedes* survey was done in 100 randomly selected houses around the airport in November 2019 (Post monsoon), of which 6 were found positive for *Aedes* breeding (HI-6%). A total of 71 containers with water were checked and 7 were with *Aedes* larvae (CI-9.85%). Most of the containers were plastic (47.89%) followed by used tires (23.94%), earthen (11.27%), metal (9.86%) and cement tanks (7.04%). *Aedes* larvae could be seen in plastic (3), metal (2), and one each for earthen and used tires. The breteau index (BI) was 7.0 (Fig.2). The adult mosquitoes reared from the larvae/pupae collected from inside and around

(residential area) airport during both the seasons were identified as *Ae.albopictus*. Mosquito-borne viruses have become significant public health problems, with the emergence and re-emergence of *Aedes*-borne diseases (ABDs) nearly worldwide. The emergence and re-emergence of ABDs is associated with complex factors, such as viral recombination and mutation, leading to more virulent and adaptive strains, unplanned urbanization, expanded conveyance facilities and human interferences creating more conducive environment for vector-host interaction. In addition to this, global warming increases vector distribution and transmission dynamics of arboviral diseases.

Generally, House index/Premise index (HI/PI) > 10% and Breteau index (BI)>20 are considered as critical. Vector surveillance in the residential areas around the airport showed that the aforesaid *Aedes* larval indices were below the critical level in both the seasons. Every year the District health authorities are giving warning to the public on impending outbreak of mosquito-borne infectious diseases and the need to observe 'pre monsoon drive' by cleaning the surroundings of the houses/shops/office buildings, etc. to avoid mosquito breeding. It seems that the local health workers and local bodies of Mattannur municipality and Kizhellar panchayath are actively involved in source reduction activities with the support of local inhabitants. The comparatively low level of *Aedes* larval indices in the residential areas in the aforesaid areas in both the seasons credited to the persistent vector control activities.

However, the premise index (PI) inside the airport in both the seasons and breteau index (BI) in post monsoon season was found above the critical level. This necessitates the need for regular vector surveillance and proper vector control activities under trained man power.

**Table.1** Surveillance of *Aedes* mosquitoes at Kannur International airport in 2019

Sl.No.	Premises	Pre monsoon						Post monsoon					
		Plastic		Metal		Earthen		Plastic		Metal		Tires	
		S	P	S	P	S	P	S	P	S	P	S	P
1	IA Terminal	-	-	-	-	-	-	-	-	-	-	-	-
2	Ground handling Parking area	-	-	-	-	-	-	4	-	2	-	-	-
3	Air India Workshop	-	-	-	-	-	-	-	-	-	-	-	-
4	Fire station East	-	-	1	1	1	-	3	-	2	-	-	-
5	AGL Substation East	-	-	-	-	-	-	-	-	-	-	-	-
6	Perimeter area	-	-	-	-	-	-	-	-	-	-	-	-
7	Fire Drill pit	-	-	-	-	-	-	-	-	-	-	-	-
8	Fire Station West	1	-	-	-	-	-	-	-	-	-	-	-
9	ATC	-	-	-	-	-	-	1	-	1	-	1	-
10	Restaurant and canteen	-	-	-	-	-	-	1	-	-	-	-	-
11	AGL Substation West	-	-	-	-	-	-	1	1	-	-	-	-
12	BharathPetroleum Company	-	-	-	-	-	-	1	1	3	2	15	-
13	Baggage break up area	-	-	-	-	-	-	-	-	-	-	-	-
14	Passenger boarding bridge	1	-	-	-	-	-	-	-	-	-	-	-
15	Reserved lounge I	5	-	-	-	1	-	-	-	-	-	-	-
16	Reserved lounge II	3	-	-	-	-	-	-	-	-	-	-	-
17	AC cooling tower	-	-	-	-	1	1	-	-	-	-	-	-
	Total	10	-	1	1	3	1	11	2	8	2	16	-

**Fig.1**

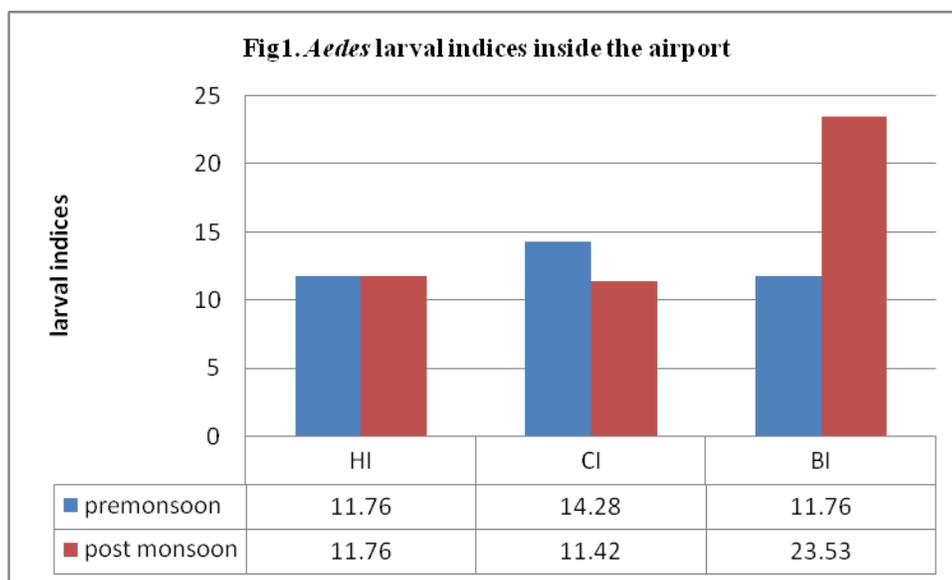
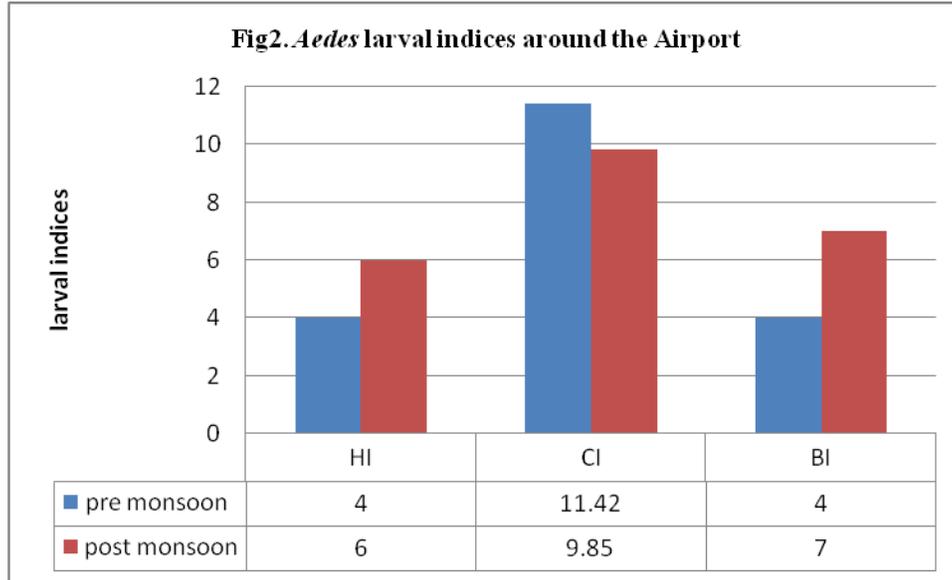


Fig.2



The Kannur International airport is commissioned on September 2018. This is the first Entomological survey done in the airport since its inception. Airport Health Officer (APHO) and trained man power for supervision and conduct of the survey is essential. The surveillance of *Aedes* mosquitoes in and around Cochin International Airport during 2013 to 2019 showed no *Aedes* larval positivity inside the airport during 2014, 2016, 2018 and 2019. In rest of the years the larval positivity was below the critical level (Rajendran, *et al.*, 2020b). A study related to the vectors of YF, DF, CHIK and Zika in New Mangalare sea port showed high level of breteau index (BI) in post monsoon season inside the port area (Rajendran, *et al.*, 2021b). However no *Aedes* larval positivity could be noted in a study conducted in pre monsoon of 2018 in the same seaport (Rajendran, *et al.*, 2019b). The high level of PI and BI observed in the present study is mainly due to the availability of breeding habitats in the air port premises during pre monsoon and post monsoon which is mainly due to summer rain and monsoon rain respectively. This in turn facilitates the breeding of *Aedes* mosquitoes. The main

intention of International Health Regulations (IHR) is to sustain vector free status at airports/seaports through planned vector surveillance and vector control measures.

Thus the impending threat on disease outbreaks can be reduced in and around the airports by preventing the entry and establishment of vectors and pathogens.

Hence a careful observance in and around international airports, seaports and ground crossings by vector control experts is needed to pinpoint the factors responsible for the establishment of disease vectors and impose bio-security and quarantine measures to avert global health risks (Kaul *et al.*, 1998).

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