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Research Article

Need for Strict Adherence to International Health Regulations - Entomological Surveillance at Mangalore International Airport

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ABSTRACT

Introduction: India, being a receptive area for yellow fever (YF), has been enforcing vector control measures to keep its international seaports, airports, and ground crossings between nations free from *Stegomyia* (*Aedes*) mosquitoes to prevent any possible introduction of YF in the country. To comply with the International Health Regulations (IHR) concerned with maintaining *Stegomyia* free zone in and around Points of Entry (PoE),entomological surveillance was carried out under the aegis of the National Centre for Disease Control (NCDC), Calicut, (Kerala branch) in and around the International airport, Mangalore, Karnataka, India.

Method: In order to assess the seasonal variation of *Stegomyia* prevalence, vector surveillance was carried out during two successive seasons i.e., first during May 2019 (pre-monsoon) and second during October 2019 (post-monsoon). The entomological surveillance was done using a structured container data format, vector prevalence study, direct observation, interviewing inhabitants and imparting awareness.

Results: In pre-monsoon, no *Stegomyia* breeding sites could be located inside the airport, while below critical level *Stegomyia* larval indices were found in the peripheral areas. In the post-monsoon study, high-level *Stegomyia* larval indices were noticed inside the airport. In the peripheral areas, as in the case of pre-monsoon observation, below critical level indices were observed.

Conclusion: The *Stegomyia* larval indices were high inside the airport during post-monsoon surveillance. This necessitates regular vector surveillance, periodic assessment and vector control activities to prevent vector-borne diseases in and around the airport.

Keywords: Entomological Surveillance, International Health Regulations, Airport

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Introduction

Among the major causes of infectious disease threats, vector-borne diseases (VBDs) alone contribute more than one million annual deaths, meanwhile, nearly half of the world population is kept at morbidity risk.[1] Among the VBDs, mosquito-borne viral diseases stand out to be the most formidable and have a persisting history of emergence and re-emergence. *Stegomyia*-borne virus diseases (SBVDs) such as dengue, chikungunya, Zika, and yellow fever have been the most prominent contagious diseases posing major global health hazards.[2] *Stegomyia* (=*Aedes*) aegypti and *Stegomyia* (=*Aedes*) albopicta are the two species transmitting dengue fever (DF) in South East Asian countries including India and other regions of the world. More than 3.9 billion people in over 129 countries are at risk of dengue infection, with an estimated 96 million symptomatic cases and approximately 40,000 deaths every year.[1] DF has become a major public health concern in many parts of the world including India. In a recent study on epidemiological stratification of dengue in India, Karnataka was placed in the high-burden category indicating the highly vulnerable disease status of the state.[3]

Chikungunya fever (CHIKF), another *Stegomyia*-borne disease, caused by the chikungunya virus (CHIKV) is also a cause of global public health concern. The virus re-emerged in India in 2005, resulting in large-scale outbreaks in several parts of the country. India witnessed major CHIKF outbreaks from 2005 to 2010. After 2010, the country experienced a steep decline in the reported cases.[4] However, in 2016, the total number of confirmed CHIKF cases rose to 64,057,of which 15,666 cases were in Karnataka alone.[5]

Zika, another *Stegomyia*-borne viral disease was reported in the states of Gujarat and Tamil Nadu in 2016 and 2017 respectively. Zika virus (ZIKV) outbreak was reported in Jaipur, Rajasthan during September-October 2018, and in Madhya Pradesh during October-November 2018.[6] An outbreak of ZIKV was reported in Thiruvananthapuram, Kerala in July 2021,[7,8,9] and since then 107 confirmed ZIKV cases were reported from the state. The recent outbreaks of ZIKV are a growing concern in the South East Asia region. Though most of the countries in Asia have favorable conditions for *Stegomyia* mosquito breeding and are considered receptive to YF transmission, the disease has never occurred in Asia. A recent study has pointed out an impending threat of transmission of YF in Asia, especially considering the rapid influx of travelers from endemic areas.[10]

Among the invasive mosquitoes recorded all over the world, *Stegomyia* species are particularly the most frequent and grave. As several of them are potential vectors of many diseases, they pose major health threats. *Stegomyia aegypti* mosquito is the main vector that transmits the viruses causing dengue, chikungunya, Zika and yellow fever. *Stegomyia albopicta* is another competent vector for transmission of dengue virus and also 22 arboviruses, including the causal agents for West Nile and Yellow fever.[11] *Stegomyia* mosquito is considered a highly domesticated mosquito, that is very adapted to living with human beings. It prefers to rest indoors and to feed on humans during daytime hours and generally breeds in man-made and natural habitats seen in and around human habitations.[12,13]

The rapid global growth of connectivity facilitates the entry and establishment of *Stegomyia aegypti* and *Stegomyia albopicta* in seaports and airports posinga potential threat of disease outbreaks. To address the global spread of VBDs and to maintain sanitary standards at international borders and PoE, the fifty-eighth World Health Assembly (WHA) adopted the new International Health Regulations.[14] The IHR envisages that all international seaports and airports should be kept free from all types of mosquito vectors for a minimum distance of 400 meters around the perimeter of the ports in order to achieve the ultimate aim of public health security. This necessitates periodic and regular vector surveillances and adoption of appropriate vector control measures in and around the ports. The present study was carried out by the NCDC, Kerala branch, on behalf of the Ministry of Health and Family Welfare, Govt of India. The objective of the study was to assess the seasonal variation of *Stegomyia* prevalence in two successive seasons i.e., first during May 2019 (pre-monsoon) and second during October 2019 (post-monsoon).

Materials and Method

Study Area

The target area of the study has been in and around MangaloreInternational Airport. The airport is located at Bajpe, approximately 7 km from the cityof Mangalore. The airport handles domestic and international flights, especially to the Middle East. This is the second busiest airport in the Karnataka state.The coordinates of the airport are Latitude $12^0 57'$North and Longitude $74^0 53'$East. This is the first airport to have two runways. The first one is a tabletop runway, 615 m long, and the other is 2,450 m long.

The premise/target area for the study includes 1) outside the airport limited to 400 meters around the perimeter of the airport, and 2) inside the airport consisting ofdifferent activity areas such as airport terminal, fire station, administrative block, runway, etc. (Table 1).

Entomological Surveillance

As part of the entomological surveillance, the following methods/tools were employed:

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Structured Container Data Format

This is used for the enumeration of different types of containers, both, water holding and dry. The water-holding containers are examined for the live larval presence and dry containers were enumerated as likely future positive containers.

Study on Vector Prevalence Field and Laboratory Observations

All the accessible water-holding containers/sources in and around houses/building premises were searched for the presence of larvae and pupae of mosquitoes and recorded in the container data sheet. The immature stages of mosquitoes from small containers (less than 10 litrecapacity) were collected using appropriate Steiner. The different stages of larvae and pupae were collected from large containers using a modified larval dipper. The larvae and pupae collected from each container/source were kept in separate vials labelled with the date of collection, name of the locality, house/building number, and breeding sources (container types/habitats). The immature mosquitoes kept in separate vials were placed in rearing jars filled with 150 ml of fresh water and were covered with a fine mosquito net. The larvae were provided with the larval food prepared by mixing 12.5 gm of tuna meal, 3.5 gm of yeast, and 9.0 gm of bovine liver powder, in 100 ml distilled water. Larvae and pupae were identified until the emergence of adults and the mosquitoes were identified using a standard key.[15]

The data on the larval survey were analyzedand calculated in terms of House Index/Activity Area Index (HI/AAI - percentage of houses/activity areas positive for larvae), Container Index (percentage of containers/sites positive for larvae) and BreteauIndex (BI number of positive containers/ sources per 100 houses).

Direct Observation

The presence of vegetation, water bodies, waste accumulation, and other possible locations for water collection and mosquito breeding were directly examined by the investigators. The observation also covered the personal hygiene habits of inhabitants and the sanitation conditions.

Interviewing Inhabitants

The inhabitants were questioned for gathering information about knowledge of mosquito vectors, vector-borne diseases, treatment, vector control practices, disease control practices, sanitary and hygiene practices, etc.

Imparting Awareness

The surveillance also included IEC through the distribution of pamphlets/leaflets/posters, etc. among the target area inhabitants and airport functionaries and staff.

Results and Discussion

Mangalore Airport (Target Area-Inside)

This consists of mainly the operational area inside the Mangalore airport. The operational area is divided into 21 different activity areas (Table 1). This is highly heterogeneous in nature regarding the kind of activities going on and the category of people working in the area depending on various enterprises and functions such as passenger entry and exit points, airport administrative offices, cargo, canteen, parking area, emergency medical care centre, fuel station, fire station, and labour camp. These areas are of great entomological surveillance significance since people from different walks of life arrive and depart from here as part of travel and different activities and occupations. Different kinds of logistics operations going on in this area also adds to the significance of the surveillance. Another reason for its surveillance importance is different carriages having entry and exit inside the airport.

In order to find out the seasonal variation of *Stegomyia* larval indices in and around the airport, the first survey was conducted in May 2019 (pre-monsoon) and the second survey was conducted in October 2019 (post-monsoon). During pre-monsoon, a total of 137 water-holding containers at 21 activity areas were examined in May 2019. No containers were found positive for *Stegomyia* larvae. The diversity of the containers consisted of 60 metal containers (43.8%), 54 discarded tires (39.42%), 18 plastic containers (13.14%), 3 earthen containers (2.2%), and 2 cement tanks (1.44%). Building based index similar to the House Index (HI) is determined inside the airport with regard to the different activity areas. There are many categories of containers that fall under the aforesaid categories in this area.

Table 1.*Stegomyia* Surveillance in Mangalore International Airport during Post-monsoon

S. No.	Different Activity Areas	Containers									
		Plastic		Metal		Tires		Earthen		Cement tank	
		S	P	S	P	S	P	S	P	S	P
1.	Airport terminal	-	-	-	-	-	-	-	-	-	-
2.	Fire station	-	-	1	1	1	1	-	-	-	-
3.	IOC	-	-	-	-	-	-	-	-	-	-

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4.	Pump house	-	-	-	-	-	-	-	-	-	-
5.	International arrival	-	-	-	-	-	-	-	-	-	-
6.	Canteen area	-	-	-	-	-	-	-	-	-	-
7.	Old terminal building	-	-	-	-	-	-	-	-	-	-
8.	Baggage up area	-	-	-	-	-	-	-	-	-	-
9.	Around runway	-	-	-	-	-	-	-	-	-	-
10.	Administrative block	-	-	-	-	-	-	-	-	-	-
11.	ATS	-	-	-	-	-	-	-	-	-	-
12.	Labour camp	3	1	4	-	92	6	1	-	3	1
13.	MTD staff room and work shop	-	-	-	-	10	-	-	-	1	1
14.	Domestic terminal	-	-	-	-	-	-	-	-	-	-
15.	Cooling plant	-	-	-	-	-	-	-	-	-	-
16.	Parking area	-	-	-	-	-	-	-	-	-	-
17.	Emergency medical centre	-	-	-	-	1	1	-	-	-	-
18.	New apron extension	-	-	-	-	-	-	-	-	-	-
19.	Parking area	-	-	-	-	-	-	-	-	-	-
20.	Apron area	3	-	3	-	3	-	-	-	-	-
21.	AC plant	-	-	3	-	2	-	-	-	-	-
	Total	6	1	11	1	109	8	1	-	4	2

S- Searched, P- Positive for *Stegomyia* larvae/pupae

During post-monsoon, a total of 131 water-holding containers were examined, of which 12 were found positive for *Stegomyia* larvae; Container Index (CI) was 9.16% and the BreteauIndex (BI) was 57.1 (Table 2). Of the total containers checked, 109 were discarded tires (83.21%) followed by 11 metal containers (8.4%), 6 plastic containers (4.58%), 4 cement tanks (3.05%), and one earthen container (0.76%). It is to be noted that all 12 containers positive for *Stegomyia* larvae were obtained from 4 activity areas namely fire station (2), labour camp (8), Motor TransportDepartment (MTD) staff room cum workshop (1), and emergency medical centre (1). The labour camp attached to the construction site reported 75% of positive containers. This is confirmatory of the kind of environment created by the labour operation going on inside the airport and how that is contributory to containers most suitable for vector proliferation.

Residential Area

The target area outside the airport consisted of a circumferential area of 400 meters radius. This area contained an inhabitant population residing in 100 houses. All the houses (100%) were brought under the present vector surveillance. The houses were visited by the study team personally and relevant data were collected. The houses were searched both inside and outside for potential vector breeding sources/locations such as containers and utensils, natural/organic breeding sites, and building-based vector breeding sources such as roof gutters, window shades, parapets, etc.

In the pre-monsoon surveillance, only 4 house premises were found positive for *Stegomyia* larvae (HI- 4%). A total of 31 water-holding containers were found in the whole area. Among the 31 containers, 24 were different types of plastic containers (77.4%) followed by 3 cement tanks (9.67%), 2 discarded tires (6.45%), and 2 earthen containers (6.45%). Of these, 6 containers were found positive for larvae (CI- 19.4%). The positive containers consisted of 4 plastic (66.66%), 1 discarded tire (16.7%), and 1 earthen container (16.7%). The BreteauIndex (BI) was 6.0 (Table 2).

In the post-monsoon surveillance, out of the total houses, only 7 were found positive for larvae (HI- 7%). Out of the 48 containers, only 7 were found positive for *Stegomyia* larvae (CI- 14.58%). The water-holding containers seen on house premises included 29 plastic containers (60.41%) followed by 15 metal containers (31.25%), 2 cement tanks (4.17%), and 2 earthen containers (4.17%). Among the positive containers, 5 were plastic containers (71.4%) and the remaining 2 were metal containers (28.6%). The BI was calculated as 8.0 (Table 2).

The adult mosquitoes reared from the larvae/pupae collected from inside and around (residential areas) the airport, in both seasons, was identified as *St.albopicta*.

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Table 2.*Stegomyia* Larval Indices In and Around Mangalore Airport

Season(s)	Houses/Premise		Containers		House/ PremiseIndex (HI/PI) (%)	Container Index (CI) (%)	Breteau xIndex (BI)
	S	P	S	P			
Inside the airport							
Pre-monsoon	21*	0	137	0	0.0	0.0	0.0
Post-monsoon	21*	4	131	12	19.04	9.16	57.1
Residential area							
Pre-monsoon	100	4	31	6	4.0	19.4	6.0
Post-monsoon	100	7	48	7	7.0	14.58	8.0

S- Searched, P- Positive for *Stegomyia* larvae/pupae,* Different activity areas

Stegomyia-borne viral diseases such as dengue, chikungunya, Zika, and yellow fever are a growing threat worldwide due to the geographic expansion of vectors and virus agents throughglobalisationand urbanisation. There is a global upsurge of SBVDs during the past 50 years. This is mainly due to the increased population growth, international travel and transport, unplanned and extensive urbanisation, socio-economic conditions, human behavior, climatic changes, and above all lack of community participation in vector control activities.

Generally, House Index/Premise Index (HI/PI) >10% and Breteau Index (BI) > 20 are considered critical. Vector surveillance in the residential areas around the airport showed that all the *Stegomyia* larval indices were below the critical level in both seasons. During the previous survey, the NCDC team had a detailed IEC intervention and interaction with the residents under the purview area. The reduced level of larval indices in the present study is indicative of the success of the aforesaid IEC activities conducted among the residents as well as the high receptivity of the residents towards the awareness programme.

In the post-monsoon survey carried out inside the airport, it was found that the Activity area index (AAI) and BI were above the critical level. The vector surveillance carried out in the old airport of Chennai in 2008 showed that all the larval indices were high. Similarly,high Container and Breteau indices were noted at Thiruchirappally airport, Tamil Nadu in the same year.[16] The surveillance of *Stegomyia* mosquitoes in and around Cochin International airport from 2013 to 2019 showed no *Stegomyia* larval positivity inside the airport in 2014, 2016, 2018, and 2019. For the rest of the years, the larval positivity was below the critical level.[17] The high AAI and BI observed in the present study during post-monsoon is mainly due to the availability of secondary foci in airport premises during the rainy season.This in turn facilitates the breeding of *Stegomyia* mosquitoes. Usually, in the southern states of our country, dengue fever (DF) starts appearing along with summer rain or with the onset of monsoon. The cases slowly increase in tune with the rain, continue through the rainy months, reach their peak post-monsoon, and then decline. The discarded tires and throw-away plastic and metal containers found in the activity areas inside the airport could very well collect water during the South-West monsoon and act as potential breeding sources of *Stegomyia* mosquitoes. It is of concern that the airport authorities were not prompt enough in keeping the premises clean of discarded and thrown away materials.

It is highly recommended that concerned airport and health authorities should invariably resort to measures for keeping the airport premises free of discarded materials on a regular basis and for avoiding sources with potential for vector breeding and proliferation. It is mandatory that vector-borne diseases(VBD) outbreaks should be forestalled in critical areas such as airports, seaports and ground crossings through strict monitoring so that entry and establishment of vector mosquitoes are effectively prevented. This also holds significance for preventing the dissemination of local vectors to distant areas through various conveyances including ships and aircraft. Vector monitoring necessitates the active involvement of vector control experts in measures and activities such as identifying the factors favoring the entry and establishment of disease vectors and implementing bio-security and quarantine measures to prevent international health threats.[18]

Conclusion

Vector surveillance was carried out in and around Mangalore International Airport during pre-monsoon and post-monsoon in 2019. It was found that AAI and BI were found above the critical level in the post-monsoon season inside the airport while no larval positivity could be noted inside the airport during pre-monsoon. The HI and BI were below the critical level in residential areas during both seasons. *Stegomyia albopicta* was the mosquito species seen in the study area. A high level of AAI and BI was noted inside the airport during post-monsoon calls which demands more vigilance on the part of airport authorities so that strict implementation of vector control strategies as envisaged by IHR is ensured.

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