

## Original Research Article

# Mosquito density in rural Kerala: a study on the trend of *Aedes* larval indices over monsoon in a rural area of Thrissur district, India

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## ABSTRACT

**Background:** Dengue is one of the most rapidly spreading mosquito-borne viral diseases in the world. *Aedes aegypti* mosquito is the main vector of dengue and Chikungunya. Entomological surveillance on *Aedes* mosquito has been standardized on different indices like House index, Container index, Breteau index. Larval indices are important predictors of outbreaks and are valuable in taking preventive measures. The objectives of the present study was to study the trend of larval indices over four months in selected wards of Kaiparambu Panchayat, Thrissur, Kerala, India and to identify the major breeding sources.

**Methods:** A series of surveys were conducted from May to August of 2017 in Kaiparambu Panchayat under the field practice area of Amala Institute of Medical Sciences Thrissur. Houses were selected serially from 4, 5 and 6 wards with roughly 120 houses being covered each month.

**Results:** A total of 489 houses were surveyed over 4 months. Overall, positive containers (with larvae) were present in 375 of 4055 potential containers showing a calculated House index (HI) is 44.4%, Container index (CI) is 11.5% and the Breteau Index is 76.7%. All three indices increased from May to June, peaked in July and dropped by August. Plastic containers were the most common source of breeding.

**Conclusions:** The indices indicate risk even in the pre-monsoon season and there is a marked rise during monsoon. Hence, control measures need to be adopted during the pre-monsoon season so as to reduce the impact of the impending outbreak.

**Keywords:** Container index, House index, Breteau index

## INTRODUCTION

Vector-borne diseases contribute up to one-sixth of the illness and disability worldwide, and of the broad category of vector-borne diseases, mosquito-borne diseases stand as the most prevalent and the most debilitating.<sup>1</sup> Among mosquito-borne diseases, dengue is one of the most rapidly spreading diseases in the world; over 40% of the world's population are estimated to be at risk of dengue infection, which amounts to more than 2.5 billion people worldwide. According to WHO, 2.5% of the affected die; while there are more than 100 million

infected every year.<sup>2</sup> In India, there has been an unacceptable increasing incidence from 2014 to 2017. As per the yearly data of National Vector Borne Diseases Control Programme (NVBDCP) in India in the year of 2017, a total of 188401 cases of dengue and 325 deaths reported in India, and the state of Kerala contributed 19994 cases and 37 deaths.<sup>3</sup> Recurrent outbreaks keep on occurring every year even after aggressive methods and newer policies.

Principal vector of Dengue is *Aedes aegypti*; *Aedes albopictus* considered as a secondary vector. *Aedes aegypti* mosquito lives in urban habitats and breeds

mostly in natural and man-made containers. *Aedes albopictus* encompasses a wide geographical distribution and can survive in both rural and urban environments. Plastic containers, water tanks, coconut shell, tires, leaves or anything that can hold water in it makes a perfect environment for the breeding of these mosquitos. Elimination of these preventable breeding sites can greatly reduce the intensity of vector prevalence and there by the incidence of the diseases caused by them.<sup>4</sup> Entomological surveillance on density of *Aedes* mosquito is essential to sustain the control measures and detect any increase in vector density and to delineate further need for source reduction and it has to be a continuum process.

The most commonly used standardized indicators for vector surveillance are larval indices, which include House index (HI), Container index (CI) and Breteau index (BI). Pupal surveys and adult surveys require more intense methods apart from observation and are time consuming. Adult surveys estimate adult population density using ovitraps, sticky traps, human landing collections or any similar traps. The larval indices are used to predict the outbreak of mosquito borne diseases and notify the community to take preventive measures. A HI greater than 5% and BI more than 20 is considered as critical levels beyond which epidemics are likely to occur and previous surveys in the state shows an outbreak is always anticipated. If the BI is above 50, the area is categorised as a very high-risk area and between 5-50% is considered as moderate risk.<sup>5</sup> A high CI suggests the need for man-made source reduction.

In this context, this study was conducted to understand the trend of larval indices as well as to identify the major breeding sources during pre-monsoon and monsoon months in a rural area of Thrissur, Kerala, India.

## METHODS

The study was conducted as a series of surveys in selected wards of Kaiparambu Panchayat under the field practice area of the Department of Community Medicine, Amala Institute of Medical Sciences Thrissur, Kerala, India. The surveys were conducted during the months of May, June, July and August, i.e., immediately prior to and during the monsoon of 2017. The houses from the ward 4, 5, and 6 were selected consecutively and each door-to-door survey targeted to cover a minimum of 120 houses every month.

Standard entomological techniques were used for the survey, wherein the houses were visited in the morning hours between 7:00 to 9:00 AM. The tools used in the larval survey included a survey form pipettes, plastic bottles, plastic bags, specimen vials with stoppers and a flashlight. After getting the consent from the head of the house, the premises of the house were meticulously searched for man-made as well as natural water collections which were potential mosquito breeding

habitats; discarded tires, metal drums, plastic drums, other metal containers, plastic buckets, flower pots, mud pots, cement tanks, and all other containers containing any volume of water were inspected.

Containers with live larvae or pupae were considered positive containers. Larvae and pupae were collected from positive containers using dipping and pipetting methods. All the larvae and pupae were brought to the field laboratory in labelled containers, transferred to holding containers placed inside Barraud cages. They were reared for a period of about 7-10 days, and species were also identified at the adult stage morphologically. The adult mosquitoes resting indoors and within the immediate vicinity outside the house were also collected. The species of the mosquitos caught were identified morphologically. Larval indices were calculated based on the following formulae:

$$\text{House index (HI)} = \frac{\text{No. of positive houses inspected}}{\text{No. of houses inspected}} \times 100;$$

$$\text{Container index (CI)} = \frac{\text{No. of containers positive}}{\text{No. of containers inspected}} \times 100;$$

$$\text{Breteau index (BI)} = \frac{\text{No. of houses inspected}}{\text{No. of positive containers}} \times 100.$$

The trends of these indices were assessed over a period. The container preference for breeding of *Aedes* larvae was also studied. The data was analysed using MS Excel sheet.

## RESULTS

A total of 489 houses were surveyed over a period of four months; a minimum of 120 houses were covered each month. Of these houses, 217 were found to be infested with *Aedes* larvae (average of 54.2 houses each month). A total of 4055 potential containers (both wet and dry) were identified, of which 3267 contained water. Of these, 375 were positive for larval breeding.

When analysed on a monthly basis, of the 122, 124, 120 and 124 houses inspected in the months of May, June, July and August, 34, 70, 77 and 36 houses were found to be infested with mosquito larvae, respectively. The House index for these months increased from 28.1% in May to 56.5% and 64.2% in June and July respectively, and then fell to 29.0% by August [Table 1].

In the surveyed households, containers identified as potential breeding sites for *Aedes* mosquito averaged 1014 each month. Of these, wet containers numbered 593, 844, 1104 and 726; and of them 34, 70, 77 and 36 were found to have larval breeding, during the months May, June, July and August respectively. The Container index rose from 6.2% in May to 14.7% and 13.1% in June and July; and reduced to 9.5% by the month August [Table 1].

**Table 1: Month-wise distribution of inspection findings and larval indices.**

Particulars	May	June	July	August
Total number of houses surveyed	121	124	120	124
Number of potential containers	1041	1302	1531	1222
Number of wet containers	593	844	1104	726
Number of infested houses	34	70	77	36
Number of positive containers	37	124	145	69
House index	28.1	56.45	64.17	29.1
Container index	3.55	9.52	9.47	5.65
Breteau index	30.58	100	120	55.65

**Table 2: Distribution of containers positive for mosquito breeding.**

		May	June	July	August
Plastic container	Wet	211	267	314	214
	Positive	12	19	22	13
Broken vessels	Wet	112	144	168	131
	Positive	3	9	8	2
Rubber tyre	Wet	53	76	87	79
	Positive	6	11	12	7
Coconut shell	Wet	38	48	77	43
	Positive	1	8	9	1
Flower vase or pots	Wet	21	36	63	41
	Positive	6	6	7	5
Tarpaulin sheet	Wet	7	18	22	11
	Positive	0	0	0	0
Water barrel	Wet	6	8	8	6
	Positive	1	1	1	0
Banana leaf	Wet	12	38	54	29
	Positive	0	0	0	0
Refrigerator tray	Wet	11	18	28	17
	Positive	1	5	4	2
Earthen pots	Wet	8	24	44	23
	Positive	1	6	7	2
Egg shell	Wet	2	6	15	4
	Positive	0	0	1	1
Other	Wet	112	161	224	128
	Positive	3	5	6	3
Total	Wet	593	844	1104	726
	Positive	34	70	77	36

Breteau index also showed marked increase from 30.6 per 100 houses inspected in May, to 100.0 in June, 120.8 in July; down to 55.6 per 100 in August. Hence all the indices were seen to rise in June, and fall by August [Figure 1]. It may also be noted that all the indices were above the low-risk cut-off in the pre-monsoon surveys, and crossed the levels for high risk during the monsoon season.

The common positive containers included plastic containers, followed by coconut shells, water tanks, tyres and plastic or tarpaulin sheets. The artificial containers indoors mostly consisted of refrigerator trays and flower pots.

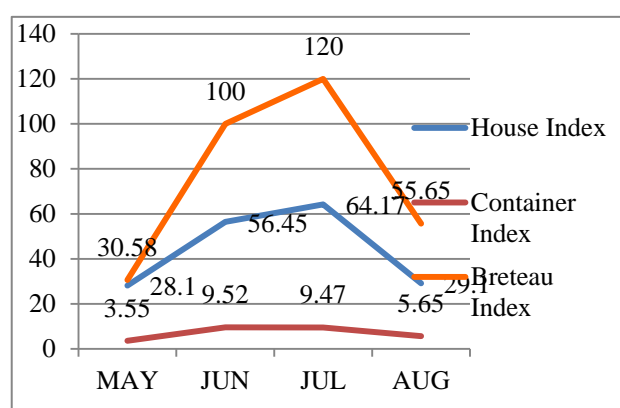
**Figure 1: Time-trend of larval indices.**

Table 2 shows that all the collected larvae, both indoors and outdoors, were found to be of *Aedes albopictus* when grown in the Barraud cage. The adult mosquitoes captured were mostly *Aedes albopictus*, followed by *Culex quinquefasciatus* and a few of *Aedes aegypti*.

## DISCUSSION

*Aedes* mosquitoes are in abundance Kerala, which makes Kerala a hotspot for vector-borne diseases; this warrants routine entomological surveillance. The larval survey is the most widely used method for entomological surveillance, for practical reasons, when compared to egg, pupal and adult surveys.<sup>6</sup> This technique was applied in this study.

Our study showed that of 489 houses surveyed, there were 375 larvae positive containers and 4055 potential containers overall. There was an increase in number of infested houses and number of positive containers in June and July, and it reciprocates very high HI, CI, BI during these months. Surveys done in May and August showed relatively lower Indices when compared to June and July, but were still on the higher side. The high indices in the months of June and July are attributed to monsoon in Kerala during these months. Kerala gets an average annual rainfall of 327.6 mm and 16.7 rain-days in the month of June.<sup>7</sup> The reason for high indices in July, despite having lower annual rainfall when compared to June may be attributed to potential man-made and natural breeding sites which logs water.

A study done in a rural area of Thrissur, Kerala, to compare the mosquito density prior to and following the floods, showed very high values for HI, CI and BI in the June survey and significantly lower indices in September 2018 (HI: 66.2 vs 1.25%, CI: 44 vs 2.77% and BI: 143 vs 1.25% per 100 houses). This drop is attributed to the heavy rains and massive floods that occurred in Kerala state during August 2018, whereby most breeding places were washed off.<sup>8</sup> A study was done to calculate larval indices in the municipal area of Perinthalmanna, Kerala in 2015 showed HI 25.15%, CI of 10.36% and BI of 73.5%, this study commenced in the month of October is comparable to our study in May and August where there is relatively low rainfall.<sup>9</sup> So, it is necessary to have focused active surveillance and to implement aggressive source reduction measures prior to the months of June and July in Kerala.

A study at Kottapuram Panchayath, Thiruvananthapuram district to study the trend of dengue vector prevalence from 2007 to 2010 showed an overall HI of 62.8%, CI 31.8% and BI of 129.8.<sup>10</sup> This was similar to a study done at Coimbatore which showed a HI of 60%, CI of 30% and BI of 60, where there is very higher container index than in our study.<sup>11</sup> This indicates that our area of study is comparatively better in terms of reduction of breeding sites, but still insufficient.

Following the epidemic of chikungunya fever in 2007, a study was done involving affected households in five

districts of Kerala. This indicated the persistence of favourable environmental factors for *Aedes*. As *Aedes aegypti* is highly adaptable to the domestic environment, its intensity increases in urban population.<sup>12</sup> In contrast, *Aedes albopictus* is widely distributed throughout the rural and urban area.<sup>4,13,14</sup> In our study, we found that *Aedes albopictus* is the most prevalent adult vector in our area of study. Though *Aedes aegypti* is known to be the principal vector causing dengue; the adaptive, invasive and flexible nature of *Aedes albopictus* has shown that it can cause significant infection even in the absence of *Aedes aegypti*. This change in trend necessitates the need for further study on bionomics of *Aedes albopictus*.

Outbreaks of dengue occurred even when vector density held extremely low through a vigorous control program and HI of 1% in Singapore.<sup>15</sup> Studies opine that values of HI of 1% or BI of 5% should be suggested to cut down dengue transmission even it lacks evidence and been proposed for the prevention of yellow fever.<sup>16,17</sup> The high breeding indices for *Aedes* larvae in Thrissur district imply their potential for dengue transmission and future outbreaks as in the previous studies.<sup>18</sup> General distribution, seasonal changes and principal larval habitats, as well as evaluating the environmental sanitation programs in an area can be determined by commonly used larval indices such as House index, Container index and Breteau index and thus necessitating the need for this study.

## CONCLUSION

The results of this study imply that the current control measures do not suffice to match the need. Control measures need to be adopted during the pre-monsoon season when reported cases are relatively low and efforts need to continue during the monsoon season where the indices are the highest. In spite of the major species being *Aedes albopictus*, a large number of positive containers were man-made such as plastic containers, highlighting the need for regulations to reduce plastic wastes. Such surveys need to be conducted at regular intervals to ensure sustained control of mosquito breeding.

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