A Study on Larval Indices of Aedes and Risk for Dengue Outbreak in a Rural Area of Thrissur District, Kerala

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ABSTRACT

Background: Mosquitoes are one of the deadliest animals in the world. Their ability to carry and spread disease to humans’ cause millions of deaths every year. Knowledge regarding the bionomics of mosquito is utmost important for developing control measures. Dengue is one of the most important and fastest re-emerging arboviral diseases, with 2.5 billion people living in areas of risk. The larval indices are easy to assess and gives the mosquito density.

Objective: This study was done to calculate standardized larval indices over a period of 5 months, to determine the major breeding sources for mosquitoes, to study the seasonal trends in larval indices in a rural residential area under Kaiparambu Panchayat of Thrissur district, Kerala.

Methods: A cross sectional study was conducted over a period of 5 months (June-October) in the houses under ARCH (Amala Rural Community health) programme of Amala Institute of Medical Sciences-Kaiparambu panchayat of Thrissur district. A house to house survey was done and every water holding container-indoor and outdoor were counted, searched for larval presence, collected and assessed. Each Larvae collected was examined and species identified. Descriptive statistics was done manually to quantify the percentage of positive containers obtained.

Result: A total of 581 houses were surveyed, 223 had larval presence. The entomological indices were respectively accounted as Container Index=29.03; House Index=49.1; Breteau Index=80.3 in June and CI=19.8; HI=32.6; BI=34.7 in October. There was seasonal variation in the indices. The commonest species of mosquito identified was Aedes albopictus.

Conclusion: The area has high risk for mosquito borne disease outbreaks, with seasonal variations and rainfall patterns. With adequate preventive measures, it can be avoided.

Keywords: Aedes, Breeding Sites, Dengue, Larval Indices, Season, Thrissur
Introduction

Mosquitoes are one of the deadliest animals in the world. Their carry and spread disease to humans causes millions of deaths annually. In 2015 malaria alone caused 4,38,000 deaths. The worldwide incidence of dengue has risen 30-fold in the three decades gone by. Zika, dengue, chikungunya, and yellow fever are all transmitted to humans by the Aedes aegypti mosquito. More than half of the world’s population live in areas where this mosquito species is present. Dengue is considered as a serious public health problem with about 2.5 billion people worldwide at risk. Dengue is caused by several closely related viruses, DENV 1,2,3,4. It is a manmade disease, as the vectors breed in containers both natural and man-made both in and around the house. In India, dengue fever and dengue haemorrhagic fever have been reported in different parts, including South India. India had as many as 87000 cases with around 150 deaths in 2017; Kerala had 18900 cases with almost 35 deaths. Over the years, the reported cases of dengue have been increasing in Kerala. Kerala is now hyper endemic for dengue with presence of multiple serotypes, high rates of co-infection and local genomic evolution of viral strains. The major species of Aedes mosquito include Aedes aegypti and A. albopictus. The dengue virus is passed on to humans through the bite of infective female Aedes mosquito. Flight range studies suggest that most Aedes aegypti may spend their lifetime in or around houses where they turn into adults. This means that people move the virus within and between communities and places.

The density of dengue mosquito fluctuates with temperature, rainfall and humidity. Dengue infections were generally conspicuous during or after heavy rainfall as an outcome of increased vector population. Aedes aegypti is a dominant species which shows wide geographic distribution in both tropical and temperate zones. Additionally, the potential and frequency for epidemics has risen because of hyperendemicity of dengue. Any containers, natural or artificial that can accumulate fresh water is a breeding site for Aedes mosquitoes. These can be indoors or outdoors. Surveillance on Ae. aegypti density is important in determining factors related to dengue transmission, in order to prioritize areas and seasons for vector control. Selection of appropriate surveillance strategies are based upon outcome/ objective, also taking into consideration time, resources, and infestation levels. Vector surveillance is required to sustain the control measures and detect any increase in vector density.

The most used indicators for vector surveillance are:

- **Larval Surveys**
  - **House index (HI):** Percentage of houses infested with larvae and/or pupae.
  - **Breteau Index (BI):** Number of positive containers per 100 houses inspected.
  - **Container Index (CI):** Percentage of water-holding containers infested with larvae or pupae.
  - **Pupa index (PI):** Number of pupae per 100 houses inspected.

- **Pupae Surveys**
  - **Pupa index (PI):** Number of pupae per 100 houses inspected.

- **Adult Surveys**
  - Estimating adult population density using ovitraps, sticky traps, human landing collections.

Generally, larval stage surveillance is best suitable. Critical levels for HI, BI are taken as 10%, 5% respectively. Levels more than this is an indication that the locality is dengue sensitive and adequate preventive measures should be taken. A BI >50%, considered high risk area, 5-50% moderate risk. Despite various efforts for eradication, a lot of countries are still affected. When it comes to susceptibility for dengue outbreaks, India tops the chart. Major factors responsible include conducive climate and environment for breeding of the vector, lack of adequate water supply leading to container storage, poverty, illiteracy, ignorance leading to poor sanitary conditions. The high population density further worsens the issue.

**Rainfall:** The rainfall amount in the State decreases towards the south with decrease of height of Western Ghats. The southernmost district of Thiruvananthapuram where Western Ghats are nearest to the sea coast and its average height is also least in the State receives minimum amount of rainfall. The southwest monsoon sets over the southern parts of the State by about 1st June and extends over the entire State by 5th June. June and July are the rainiest months, each accounting individually to about 23% of annual rainfall.

**Objectives**

- To determine the standardized larval indices (CI, HI, BI) over a period of 5 months in a rural area of Thrissur district, Kerala.
- To determine the major breeding sources for mosquitoes in a rural area of Thrissur district, Kerala.
- To assess the seasonal trends in larval indices from June to October in a rural area of Thrissur district, Kerala.

**Materials and Methods**

A cross sectional survey was conducted in 581 houses in Kaiparambu panchayat of Thrissur district under the ARCH programme of Amala institute of medical sciences, Thrissur during June 2018 to October 2018.

A house to house survey was done by a team consisting of 5 undergraduate medical students, 1 post-graduate student, 1 medico social worker, 1 staff, 1 health inspector, 1 entomologist. The study covered the time period extending from the monsoon and post monsoon. The group of 10
covered 581 houses over a period of 5 months. Pipettes, plastic bottles, plastic bags, a specimen test tube with stoppers, pens, a label and a flashlight were used to collect specimens as shown in figure 4. After attaining consent from the house owners, the premises of each house were searched thoroughly both indoor and outdoor and from each positive container, the larva was pipetted into a plastic cup/ plastic bag and were brought to the laboratory for identification. The type of positive containers, larval presence was entered on a pretested proforma. The larval indices were calculated:
- $CI = \frac{\text{No. of positive containers}}{\text{No. of containers inspected}} \times 100$
- $HI = \frac{\text{No. of positive houses}}{\text{No. of houses inspected}} \times 100$
- $BI = \frac{\text{No. of positive containers}}{\text{No. of houses inspected}} \times 100$

**Prioritizing Areas**
Depending on the potential for outbreak, an area can be placed into one of the four categories:  
- Priority I: Death due to dengue confirmed.
- Priority II: $HI >5$, $BI >20$.
- Priority III: $HI <5$, $BI <20$.
- Priority IV: despite active search, no breeding sites found positive.

**Data Analysis**
Descriptive analysis was done manually to calculate the larval indices and the proportion of different types of containers.

**Result**
In this study, a total of 581 houses were surveyed over a period of 5 months (June-112; July-60; August-128; September-137 and October-144). 223 (38%) houses had positive containers. The potential vector breeding sites which were identified during the survey are given in Table 1. Different types of containers were identified as shown in Figure 1. The no. of positive containers among the wet containers in each month as are given in Table 2. The most common site for vector breeding as per the survey was identified to be plastic buckets (33.8%) and the least was grinding stone (0.67%). 11.7% of fridge trays showed larval presence. It is an important indoor vector breeding site. The larval indices for each month are shown in Table 3. All the larval indices calculated were above the critical level for risk of outbreak of mosquito borne diseases especially Dengue. The trend in the vector indices over the 5 months are depicted in Figure 3. Aedes albopictus was the most common species identified.

| Container      | June Wet | June Dry | July Wet | July Dry | August Wet | August Dry | September Wet | September Dry | October Wet | October Dry |
|----------------|----------|----------|----------|----------|------------|-------------|---------------|---------------|-------------|-------------|
| Plastic bucket | 95        | 49       | 52       | 10       | 126        | 21          | 105           | 58            | 60          | 10          |
| other plastics | 53        | 10       | 28       | 5        | 92         | 24          | 88            | 20            | 43          | 10          |
| Rubber tyre    | 15        | 0        | 20       | 5        | 30         | 5           | 68            | 10            | 41          | 5           |
| Coconut shell  | 69        | 10       | 32       | 8        | 65         | 11          | 57            | 13            | 13          | 16          |
| Egg shell      | 9         | 0        | 0        | 0        | 12         | 2           | 51            | 5             | 24          | 8           |
| Flower pot     | 22        | 5        | 11       | 5        | 12         | 6           | 10            | 40            | 6           | 0           |
| Earthen pot    | 36        | 5        | 19       | 2        | 27         | 10          | 0             | 0             | 4           | 0           |
| Bottles        | 55        | 15       | 4        | 2        | 23         | 0           | 0             | 0             | 50          | 43          |
| Fridge tray    | 7         | 0        | 0        | 0        | 5          | 0           | 4             | 0             | 1           | 0           |
| Tarpaulin sheet| 7         | 0        | 2        | 0        | 12         | 0           | 5             | 0             | 4           | 0           |
| Tin            | 12        | 0        | 0        | 1        | 4          | 0           | 0             | 0             | 6           | 0           |
| Banana leaf    | 0         | 0        | 0        | 0        | 5          | 0           | 0             | 0             | 0           | 0           |
| Grinding stone | 1         | 0        | 1        | 0        | 0          | 0           | 0             | 0             | 0           | 0           |
| Total          | 381       | 94       | 169      | 38       | 413        | 79          | 388           | 146           | 252         | 92          |
Table 2. Number and type of containers with larval presence from June-October 2018

| Container     | June       | July       | August     | September  | October    |
|---------------|------------|------------|------------|------------|------------|
|               | Wet | Positive (%) | Wet | Positive (%) | Wet | Positive (%) | Wet | Positive (%) | Wet | Positive (%) |
| Plastic bucket| 95  | 31 (32.6)    | 52  | 19 (33.3)    | 126 | 19 (15)      | 105 | 24 (22.8)    | 60  | 16 (26.6)    |
| other plastics| 53  | 19 (35.8)    | 28  | 5 (17.8)     | 92  | 13 (14.1)    | 88  | 4 (4.5)      | 43  | 6 (13.9)     |
| Rubber tyre   | 15  | 4 (26.6)     | 20  | 6 (30)       | 30  | 7 (23.3)     | 68  | 8 (11.7)     | 41  | 12 (29.2)    |
| Coconut shell | 69  | 710 (1.1)    | 32  | 4 (12.5)     | 65  | 12 (18.4)    | 57  | 5 (8.7)      | 13  | 0 (0)       |
| Egg shell     | 9   | 2 (22.2)     | 0   | 0 (0)        | 12  | 0 (0)        | 51  | 2 (3.9)      | 24  | 3 (12.5)    |
| Flower pot    | 22  | 12 (54.5)    | 11  | 9 (41.6)     | 12  | 5 (41.6)     | 10  | 2 (20)       | 6   | 0 (0)       |
| Earthen pot   | 36  | 2 (5.5)      | 19  | 7 (36.8)     | 27  | 3 (11.1)     | 0   | 0 (0)        | 4   | 0 (0)       |
| Bottles       | 55  | 7 (12.7)     | 4   | 2 (50)       | 12  | 4 (17.3)     | 0   | 0 (0)        | 50  | 7 (14)      |
| Fridge tray   | 7   | 1 (14.2)     | 0   | 0 (0)        | 5   | 0 (0)        | 4   | 0 (0)        | 1   | 1 (100)     |
| Tarpaulin sheet| 7  | 1 (14.2)     | 2   | 1 (50)       | 12  | 1 (8.3)      | 5   | 3 (60)       | 4   | 3 (75)      |
| Tin           | 12  | 4 (33.3)     | 0   | 0 (0)        | 4   | 3 (75)       | 0   | 0 (0)        | 6   | 2 (33.3)    |
| Banana leaf   | 0   | 0 (0)        | 0   | 0 (0)        | 5   | 2 (40)       | 0   | 0 (0)        | 0   | 0 (0)       |
| Grinding stone| 1   | 1 (100)      | 1   | 1 (100)      | 0   | 0 (0)        | 0   | 0 (0)        | 0   | 0 (0)       |
| Total         | 381 | 91 (23.8)    | 169 | 37 (21.8)    | 413 | 69 (16.7)    | 388 | 48 (12.3)    | 252 | 50 (19.8)   |

Figure 1. Type of containers

Figure 2. Containers
Discussion

Our study showed that out of 581 houses surveyed, a total of 223 houses showed larval presence. The most common site of vector breeding was identified as plastic buckets in our study. This was similar to a study done at Thiruvananthapuram and Jammu in 2013. In our study, 18.4% (295/1603) containers were positive for larval presence, while in a study conducted by Sekhon H et al., a total of 48.7% containers were positive. The difference may be due to the longer time period of the study and the region where the study was conducted. Our study covered both the heavy monsoon and post monsoon period. The larval indices found in the above-mentioned study were CI/HI/BI=58%, 48.75%, 10.18 respectively. A study conducted in a rural village in Maharashtra in 2006, found HI, CI, BI as 13.6%, 2.8%, 10.3 respectively. Studies done in island areas of India found that common that breeding sites for *Aedes aegypti* are small cement tanks, used tyres, solid waste material holding rain water, and, for *Aedes albopictus*, they are small pots holding drinking water for birds, metallic containers holding rain water, and tree holes. Similar studies done in another endemic state recorded the HI, CI and BI as 53.90, 19.38 and 177.06, respectively. These high indices were the cause of sudden spurt of dengue cases in this region. The maximum positivity of *Aedes* larva was found in coconut shells and discarded tyres during this study. A study conducted in yet another state endemic for dengue yielded similar results. The major species identified were that of *Aedes albopictus*. It is also the commonest species of *Aedes* found in South India. Generally, *Ae. aegypti* is highly adapted to the domestic environment and, therefore, the abundance is positively correlated with increasing urbanization. On the other hand, the distribution of *Ae. albopictus* is associated with vegetation throughout rural and urban areas. In Kerala, there is relatively thick vegetation in both urban and rural areas and this may be the reason for the similar distribution of the species in both the areas. Major wash off of the containers after the rainfall and increased awareness among the inhabitants might have led to a decrease in the larval indices over the 5-month period.

Conclusion

This study gives a very clear indication that the study area is highly prone and comes under priority II for vector borne disease like dengue fever. A potentially explosive outbreak can occur in this area especially during the monsoon season. Wet plastic buckets and other discarded plastic containers were a major source of vector breeding. There was a gradual decrease in the larval indices from June to October, mostly due to wash off by rains. Fridge trays and flower pots were a great indoor source of vector breeding. In the recent past, there has been confirmed cases of Dengue in the study area, with no deaths. This obviates the need for adequate vector control measures and increased awareness to the inhabitants regarding the need for clearing vector breeding sites and using personal protection during the time of

### Table 3. CI, HI, BI of June-October 2018

| Month   | CI (%) | HI (%) | BI (%) |
|---------|--------|--------|--------|
| June    | 23.88  | 49.1   | 81.25  |
| July    | 21.8   | 40     | 61.6   |
| August  | 16.7   | 32     | 53.9   |
| September | 12.3 | 40.8   | 35     |
| October | 19.8   | 32.6   | 34.7   |

CI=Container index, HI=House index, BI=Breteau index.
monsoon. Clearing of water holding containers, emptying earthen pots after use, discarding old tyres by filling sand in them are some of the ways by which vector breeding can be prevented. A large hand in this matter has to be made both in terms of financial and public support from the rural local governing bodies.

**Recommendation**

Proper methods like health talks, introduction of dry days and proper cleaning of houses. It is recommended that such periodic cleaning takes place regularly on a regular basis in all Panchayath along with awareness classes. Since plastic containers and buckets were a major vector breeding source in our study, plastic waste management measures should be given utmost importance.

**Conflicts of Interest:** None

**References**

1. Mosquito borne diseases. Available from: www.who.int. Last accessed on 3rd November 2019.
2. Sekhon H, Minhas S. A Study of larval indices of Aedes and the risk for dengue outbreak. *Sch Acad J Biosci* 2014; 2(8): 544-547.
3. Kabilan L, Balasubramaniam S, Keshava SM et al. Dengue disease spectrum among infants in the 2001 dengue epidemic in Chennai, Tamil Nadu, India. *Journal of Clinical Microbiology* 2003; 41: 3919-3921.
4. Kerala, Karnataka, Tamil Nadu worst hit by dengue this year. 2017. Available from: https://www.livemint.com/Politics/YYIdlEDGJUZT71mI8vk3vK/Kerala-Karnataka-Tamil-Nadu-worst-hit-by-dengue-this-year.html. Accessed on 3 November 2019.
5. Vijayakumar K, Sudheesh Kumar TK. A study on container breeding mosquitoes with special reference to Aedes (Stegomyia) aegypti and Aedes albopictus in Thiruvananthapuram district, India. *J Vector Borne Dis* 2014; 51(1): 27-32.
6. Dengue mosquitoes. Available from: www.who.int. Last accessed on 3rd November 2019.
7. Vector surveillance. Available from: www.who.int. Last accessed on 3rd November 2019.
8. Samuel PP, Thenmozhi V, Nagaraj J et al. Dengue vectors prevalence and the related risk factors involved in the transmission of dengue in Thiruvananthapuram district, Kerala, South India. *J Vector Borne Dis* 2014; 51(1): 313-319.
9. Performance of monsoon. Available from: www.imdtn.gov.in. Last accessed on 3rd November 2019.
10. Jesha M, Sebastian N, Haveri SP et al. Mosquito density in urban Kerala: a study to calculate larval indices in municipal area of Perinthalmanna. *Indian J Forensic Community Med* 2015; 2(1): 7-12.
11. Minhas S, Sekhon H. Entomological survey for dengue vector in an institutional campus to determine whether potential of dengue outbreak exists. *International Journal of Medical and Applied Sciences* 2013; 2(4): 164-171.
12. Sharma RS. Entomological studies during outbreak of chikungunya in Marathwada region of Maharashtra. *Indian Journal for the Practising Doctor* 2006; 3(5).
13. Hawley W. The biology of Aedes albopictus. *J Am Mosq Control Assoc* 1988; 1(Suppl): 1-39.
14. Katyal R, Kumar K, Gill KS. Breeding of Aedes aegypti & its impact on Dengue/DHF in rural areas. *Dengue Bulletin* 1997; 21: 93-95.
15. Sharma SK, Hamzakoya KK. Geographical spread of Anophelestephensi, vector of urban malaria & Aedes aegypti, vector of dengue /DHF in the Arabian sea islands of Lakshadweep, India. *Dengue Bulletin* 2001; 25: 88-91.
16. Singh RK, Das MK, Dhiman PC et al. Preliminary investigation of dengue vectors in Ranchi, India. *Journal of Vector Borne Disease* 2008; 45: 170-173.
17. Mahadev PVM, Fulmal PV, Mishra AC. A preliminary study of multilevel geographical distribution & prevalence of Aedes aegypti in the state of Goa, India. *Indian J Med Res* 2004; 120: 173-182.
18. Chan KL, Ho BC, Chan YC. Aedes aegypti (L) and Aedes albopictus (Skuse) in Singapore City, 2 Larval habitats. *Bull World Health Organ* 1971; 44: 629-633.
19. Tsuda Y, Suwonkerd W, Chawprom S et al. Different spatial distribution of Aedes aegypti and Aedes albopictus along an urban-rural gradient and the relating environmental factors examined in three villages in northern Thailand. *J Am Mosq Control Assoc* 2006; 22: 222-228.
20. Hawley W. The biology of Aedes albopictus. *J Am Mosq Control Assoc* 1988; 1(Suppl): 1-39.