Study on the Correlation of Premises Condition Index and the Presence of Larvae of Aedes Species Mosquitoes in Human Dwellings of the Cuddalore District of Tamil Nadu, India

Parasuraman Baskera,*, Radhakrishnan Ezilb

aDepartment of Public Health & Preventive Medicine, Cuddalore 607001, Tamil Nadu, India.
bNational Institute of Epidemiology, Chennai 600077, Tamil Nadu, India.

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Abstract

Objectives: To predict dwellings for the presence of Aedes larvae rapidly based on Premises Condition Index (PCI) factors, we studied the possible presence of Aedes species mosquitoes larvae among houses in the Chidambaram urban of Cuddalore District in Tamil Nadu, India based on the scores of variables in PCI, namely House, Yard and degree of shadow. Data of these variables were collected in September and October 2006 from 1813 houses in the Chidambaram urban area during the intensive vector control activities employed for the prevention and control of Chikungunya.

Methods: The association between presence of larvae and the variables of PCI was tested by Chi-square and Correlation. The predictability of the presence of Aedes larvae based on PCI factors was computed by logistic regression.

Results: The study shows 301 containers in 132 houses were found positive with Aedes species out of 1813 houses surveyed. It was further observed that the probability of presence of positive premises was four times higher in the premises with 75% shadow compared with premises with a 25% shadow. These findings showed a significant association ($p < 0.001$) with positive premises.

Conclusions: It is concluded that this study helps in conducting rapid survey to identify the presence of Aedes larvae with a minimum number of staff for both inspection and treatment of Aedes larvae during the epidemic situation.

1. Introduction

The prevention and control of communicable diseases depend on the natural history of diseases. Vector-borne diseases can be prevented and controlled mainly by vector control [1]. In particular, chikungunya and dengue can be controlled only by effective vector control because there is neither a specific treatment nor
an effective vaccine to reduce or prevent the disease in the community [2]. Among the vector control practices in India, chemical control is given more priority than others. As far as chikungunya and dengue, *Aedes aegypti* and *A albopictus* are primary vectors [3]. These are usually bred in wet containers and, hence, source reduction is the best way of vector control rather than chemical control [4]. Chikungunya transmission has been studied less extensively compared to malaria, filariasis, and dengue. Dengue surveillance has vector indices, namely, Breteau (number of infested containers per 100 premises), house (percent houses infested), and container (percent wet containers infested) [5]. Although these larval indices are generally considered to have a poor relationship with adult abundance; therefore, the definition of dengue risk is considered to be questionable [1,6]. Despite that, these indices were employed in the recent episode of chikungunya transmission in Tamil Nadu for sustainable management of *Aedes* species mosquitoes. A methodology was searched to conduct rapid *Aedes* survey among human dwellings of the Chidambaram urban area of the Cuddalore District to identify the presence of *Aedes* larvae quickly to reduce its sources with the help of a premises condition index (PCI) [6,7]. In this study, PCI variables, types of houses, hygienic condition of yards, and degree of shade were employed to identify the presence of *Aedes* larvae to conduct surveys rapidly with a minimum number of workers.

2. Materials and Methods

2.1. Study area

The study area Chidambaram is situated in the Cuddalore District of Tamil Nadu state, India. Its latitude is 11°24′N and the longitude is 79°42′E. Chidambaram is a municipal town and it has 33 wards with the population of 54,000. A total of 33 streets were selected from 33 wards. The selection of the street was made each lot. All the houses situated in a street were subjected to this survey. The survey was conducted during the peak chikungunya transmission months of September to October 2006. As these months fell in the wet season, so *A. spp* were expected to be in great abundance.

2.2. Premise variables

The house condition, the yard condition, and the degree of shadow were taken for this survey. Prior to collecting the details of PCI variables such as house condition, the yard condition, and the degree of shade, these were familiarized to the investigators with their definition. House (it is a human living place. Its condition is being determined by the periodical maintenance of inmates), yard (this is some space available either in front of the house or at the back of the house) and the degree of shadow is determined based on the vegetation in and around the house. These are defined as adopting of the reference [6,8]. The house conditions were classified as 1 = well maintained house (e.g., newly painted, or new house); 2 = moderately well, a maintained house; and 3 = not a well-maintained house (e.g., paint peeling, broken items visible, dilapidated, especially if old). The yard conditions were classified as 1 = tidy yard (e.g. well-maintained gardens and debris and litter free); 2 = moderately tidy yard; and 3 = untidy yard, trash abundant, and overgrown vegetation. Shade conditions were classified as 1 = very little or no shade (≤25%), e.g. no major trees or shrubbery; 2 = some shade with major trees and vegetation (50%) and shady, e.g., large trees, shrubbery, green house, or shade cloth used; and 3 = having major trees and shrubs (75%). Categories 1 and 3 were relatively easy to score because they represented opposites. Category 2 was often selected by default. A presurvey was conducted in the residential areas of the Chidambaram urban area so that the features of these variables would remain in the investigators’ minds. The outcome of the presurvey was compared with the actual survey, which was conducted by the skilled investigators, namely senior entomologists and entomological assistants. This was repeated until the outcome was the same. For this survey, lab assistants, field assistants, and field workers of the National Filarial Control Programme in Chidambaram were employed.

2.3. Container data

A total of 1,813 premises were inspected from September to October 2006 in Chidambaram Town of Cuddalore district in Tamil Nadu, India, and scored as indicated above. The presence of immature of *A spp* mosquitoes and the number of positive containers was recorded for each.

| House condition            | Positive premises, no. | Percentage | Negative premises, no. | Percentage | Total |
|----------------------------|------------------------|------------|-------------------------|------------|-------|
| Well maintained            | 43                     | 4.6        | 888                     | 95.4       | 931   |
| Moderately maintained      | 73                     | 9.6        | 686                     | 90.4       | 759   |
| Not well maintained        | 16                     | 13.0       | 107                     | 87.0       | 123   |
| Total                      | 132                    | 1,681      |                         | 87.0       | 1,813 |
2.4. Statistical methods

Statistical methods such as the Chi-square test, trend Chi-square, and logistic regression analysis were used. To examine the association of wet containers that were positive for A spp with variable premises, univariate and multivariate analysis were performed. The unadjusted and adjusted odds ratio was computed for positivity of A spp with variable premise. All analyses were two-tailed and a p value of <0.05 was considered statistically significant. Statistical analysis was performed by using SPSS version (SPSS IBM Company, Chicago-3, USA) 10.0 packages.

3. Results

This study was conducted in the Chidambaram urban area of Cuddalore District, Tamil Nadu, India, during the months of September to October 2006. A total of 1813 households were surveyed and 132 premise households were found to be positive. The distribution of positive premises by house conditions and shade conditions is described in Tables 1 to 3. It was observed that the positive premise were significantly higher (p < 0.05) in houses that were not well maintained, with untidy yard conditions, and very little shade.

The PCI was computed based on three premise variables, such as house condition, yard condition, and shade conditions. There was a positive correlation between PCI and the proportion of positive premise (r = 0.171; p = 0.01) and with the number of positive containers in the premise (r = 0.153; p = 0.01).

A significant increasing trend was observed between the proportion of positive premises and the PCI score (p = 0.001; Table 4). It was observed that there was a 5.6 times greater probability of detecting positive premises in highest score compares with the lowest score index.

These three variables were used simultaneously to find any observed association with positive premises and was examined by employing logistic regression analysis. It was observed that the degree of shade shows a significant association (p = 0.001) with positive premises when adjusted for house and yard conditions. In fact, the possibility of detecting positive premises was four times higher in the premises with more shade (75%) compared with premises with very little shade (25%; Table 5).

4. Discussion

Several communicable diseases are endemic in India. An effective surveillance system is essential for planning, implementation, and monitoring of disease control programs. Many of these diseases have seasonal and cyclic trends, which can be detected through the surveillance system [9]. These diseases can also cause outbreaks with the potential to spread rapidly and cause many deaths in general [10]. The recent outbreak of chikungunya in southern parts of India taught many lessons about its control and prevention. Among them, vector control activities employed with the political commitments of Government of Tamil Nadu and the Government of India involving all the components of Primary Health Centers had been received more attention as it was exclusively dependent on the source reduction of Aedes species larvae in human dwellings than chemotherapy. It is known that there is no treatment available to destroy the causative organism, the chik virus. In this situation, as per the guidelines of WHO [2], entomologic surveillance was used to

| Table 2. Distribution of positive premises by yard condition |
|-------------------------------------------------------------|
| Yard condition                  | Positive premises, no. | Percentage | Negative premises, no. | Percentage | Total |
|--------------------------------|------------------------|------------|------------------------|------------|-------|
| Tidy yard                      | 42                     | 4.6        | 880                    | 95.4       | 922   |
| Moderately tidy                | 67                     | 9.3        | 652                    | 90.7       | 719   |
| Untidy                         | 23                     | 13.4       | 149                    | 86.6       | 172   |
| Total                          | 132                    |            | 1,681                  |            | 1,813 |

| Table 3. Distribution of positive premises by shade condition |
|---------------------------------------------------------------|
| Shade condition                  | Positive premises, no. | Percentage | Negative premises, no. | Percentage | Total |
|---------------------------------|------------------------|------------|------------------------|------------|-------|
| Very little shade               | 42                     | 4.0        | 1,020                  | 96.0       | 1,062 |
| Some shade                      | 45                     | 9.6        | 423                    | 90.4       | 468   |
| More shade                      | 45                     | 15.9       | 238                    | 84.1       | 283   |
| Total                           | 132                    |            | 1,681                  |            | 1,813 |
determine changes in the geographic distribution and
density of the vectors, evaluation of the control program,
obtain relative measurements of the vector population
time, and facilitate appropriate and timely decision
regarding intervention. Besides, a number of methods
are available for detecting or monitoring immature and
adult populations through the selection of appropriate
sampling methods depend on the surveillance objec-
tives, levels of infestation, available funding, and skills
of personnel [11]. Further, the guidance of the choice of
surveillance methods for A aegypti are comprised of the
following: (1) baseline infestation surveys; (2) control
program that monitors low infestation level of <5%
house index; (3) control program that monitors the level
>5% house index; (4) surveillance against reinfestation;
and (5) verification of eradication and evaluation of the
control methods. Among the methods on vector control,
larval survey, collection on humans, collection of resting
mosquitoes, ovitraps, tyre, larvitraps, and insecticide
susceptibility tests are appropriate [12]. Scrutinizing
these methods of evaluation, larval survey is the fore-
most as it employs for complete source reduction of
Aedes species and hence the PCI was tested on the
presence of Aedes larvae species through the correlation
of its variables house, yard condition and degrees of
shadows for its application in rapid survey of Aedes
species apart from HI, container Index and breateau
Index have been described and we currently use them to
monitor Aedes species population for dengue virus
transmission.

In the present study, three variables—house, yard,
and degrees of shadow—were used simultaneously to
find any observed association with positive premises
was examined by employing logistic regression analysis.
Among the premise variables, we observed the degree
of shade association is more with positivity of Aedes
species when adjusted for house and yard. Also it is
noted the probability of detecting positive premises was
four times higher in the premises with 75% shade
compared with the premise with 25% shade. Toward the
same line of observation, the morbidity status of chi-
kungunya was also examined that signs and symptoms
of it were observed in dwellings with sources of Aedes
breeding and 75% degree of shadow irrespective of
house and yard condition (data unpublished). Hence, the
degree of shadow could be one of the factors to be
considered for developing PCI index. Going through the
literature, it was known that shade level can be accu-
rately identified even from the aerial with the help of
both color and infrared images and the positivity of
larvae was compared with variables (house, yard, and
degrees of shadow). It was known that there was no
much variation in the prediction of positivity using all
these variables put together rather than degrees of
shades alone [8]. Similarly [6], Tun-Lin stated that the
PCI was developed as a rapid, cost-effective surveil-
ance technique for identifying premises at high risk of
breeding A aegypti. The PCI is a simple index incor-
porating predictors of A aegypti breeding (shade levels,
yard tidiness, and house condition) that does not require
the inspector to enter the premises. However, weak-
nesses of the PCI include the inability of the inspector to
see into many rear yards and the risk of inconsistent PCI
scoring between different health inspectors. The control
and prevention of dengue and chikungunya solely
depend on vector control methods either through the

| Table 4. The proportion of positive premises and the premises condition index score |
|----------------------------------------|----------------|----------------|--------------------------|----------------|--------------------------|
| Total score | Houses surveyed, no. | House positive | Container positive | Proportion of positive houses | Percentage | Mean no. of containers | Percentage |
|-------------|----------------------|-----------------|-------------------|-----------------------------|-------------|----------------------|------------|
| 3           | 589                  | 25              | 50                | 0.04                        | 4.24        | 0.08                 | 8.49       |
| 4           | 273                  | 7               | 24                | 0.03                        | 2.56        | 0.09                 | 8.79       |
| 5           | 416                  | 23              | 37                | 0.06                        | 5.53        | 0.09                 | 8.89       |
| 6           | 280                  | 33              | 71                | 0.12                        | 11.79       | 0.25                 | 25.36      |
| 7           | 153                  | 26              | 79                | 0.17                        | 16.99       | 0.52                 | 51.63      |
| 8           | 67                   | 11              | 25                | 0.16                        | 16.42       | 0.37                 | 37.31      |
| 9           | 35                   | 7               | 15                | 0.20                        | 20.00       | 0.43                 | 42.86      |
| Total       | 1,813                | 132             | 301               |                             |             |                      |            |

| Table 5. Adjusted odds ratio for positive premise according to house, yard, and shade conditions |
|---------------------------------------------------------------|-----------------|--------------------|-----------------------------|-------------|
| Type of condition | Adjusted odds ratio | 95% confidence interval for adjusted odds ratio | p              |
| House             |                      |                    |                |
| Well              | 1.00                |                    |                |
| Moderate          | 0.57                | 0.24–1.30          | 0.181          |
| Not well          | 0.83                | 0.41–1.66          | 0.591          |
| Yard              |                      |                    |                |
| Tidy              | 1.00                |                    |                |
| Moderate          | 1.30                | 0.73–2.31          | 0.370          |
| Untidy            | 1.28                | 0.58–2.76          | 0.538          |
| Shade             |                      |                    |                |
| Very little       | 1.00                |                    |                |
| Some              | 2.22                | 1.42–3.47          | <0.001         |
| More              | 3.82                | 2.38–6.12          | <0.001         |
source reduction evaluated by indices of HI, PCI, and Berteau index or through the application of larvicides and insecticides [13, 14]. Therefore this study helps to conduct the rapid survey of Aedes species mosquitoes in a place with a minimal number of manpower and in turn, with the help of PCI, delimitation is very possible among villages and hamlets situated in a primary health center area based on the sources of Aedes species breeding habitats [15–17]. It varies based on peoples’ habits, such as water management, water storing habits due to water scarcity, occupation associated with water, like cement works. To employ PCI throughout our state of Tamil Nadu, more experimental studies may be required to make it more suitable.

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