Environmental Risk Mapping for Dengue Fever Transmission in a Rural Area, Tamil Nadu

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Abstract
Dengue is a systemic viral infection transmitted between humans by Aedes mosquitoes. Dengue is a viral infection which originates from mosquitoes. Dengue is caused by a virus called the dengue virus (DENV). Most notably, there are four major DENV serotypes. Therefore it is possible to be diseased by either four or all four of them. As seen in most cases, DENV infections usually cause a mild infection, but it can also lead to an acute flu-like illness. Occasionally this proliferates into a possibly deadly problem, called severe dengue. The detection and mapping of dengue risk areas is a multifaceted, tiring, complicated and extended task requiring evaluation of many criteria. It is not sure that always one single factor is liable for Dengue Fever transmission in all areas, but it differs with changing geographical location. The main objective of the present study is to prepare an environmental risk mapping for dengue transmission in a rural area, Tamil Nadu and access the level of risk the people of that area are in and how susceptible they are to dengue. A total of 40 houses were observed for risks of dengue using a questionnaire and by looking around the house for possible hotspots after screening for inclusion and exclusion criteria. There is hence a need for educational programs to facilitate awareness and promote sensible practices to avoid dengue. Every individual should also follow precautionary guidelines taking into consideration the risk of dengue. This study serves to spotlight the possible current risk in contracting dengue due to poor household habits and lack of awareness in a rural area.

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Introduction
One of the most common arboviral diseases passed to human beings from mosquito vectors is Dengue fever (DF) belonging to the genus Aedes (Gubler and Monath, 1988); the key factors affecting the spread of this virus include mixing virus serotypes, the vulnerability of human populations and mosquito density (Kuno, 1997).

The only manner to control this deadly virus is to impose vector control as there is no vaccine or precis treatment; this invariably places greater importance on prediction and identification of possible risk areas to assist in dengue prevention (Bohra and Andrianasolo, 2001).

There are many parameters and reasons to determine the reasons for the expansive rise of dengue. These include growth of human population, nature of vectors, the biology of population, the natural course of the history of the virus, human actions...
against nature and many more. In terms of environmental factors, rainfall, temperature, humidity are well-known determinants that can affect various developmental phases of dengue vector thereby limiting the occurrence of DF (Wet et al., 2001; Getis et al., 2003; Hales et al., 2002).

The goal of effective and efficient risk assessment can be achieved by a broader-scale and prognostic point of view which asess risk that is not only about the already sampled areas but also expanded to new, unsampled areas analytically and logically (Arboleda et al., 2009). The study of risk mapping is one of the components used to evaluate the risk patterns of health care practitioners as well as recommends necessary changes in the living conditions to provide the best environment to the patient. Thereby risk mapping studies are an essential indicator to judge the quality and standard of living among individuals of a specific area. The current study is aimed to analyze the living conditions of people of a rural area and evaluate the risks of dengue in that region. This will help us gain knowledge on the prevalence of dengue in that locality and finally assessing the trend of dengue cases.

Aims and Objectives
To determine the household and environmental risk factors for dengue transmission in a rural area, Chennai.

Methodology
Study Design
Cross-sectional Study.

Study Duration
The study was conducted for a period of 3 months, starting from Jan 2020 to March 2020.

Study Participants
Adult above 18yrs who will be available at the household

Study Area
The study was conducted in Mappedu, Tamilnadu

Sample size
All the 40 houses from the three different streets near the rural health Centre were included in the study.

Study Tool and Data Collection
A Pre-tested, validated, structured and self-administered questionnaire consisting of their socio-demographic details, assessment of environmental factors of household and assessment of potential breeding sources. Data were obtained from each house after rigorous scrutiny and careful examination, accessible areas were thoroughly covered. Epi-collect 5 was used to collect relevant data.

Informed consent
It was obtained from all the study participants before eliciting the desired information.

Inclusion criteria
All houses in a particular location were included in the study.

Exclusion criteria
The study participants who didn’t give proper responses to specific questions.

Ethical clearance
The study was carried out after getting approval from the Institutional Ethics Committee. Permission to carry out the study was also obtained from the Head of Community Medicine Department before starting the study.

RESULTS
Socio-demographic details of study participants
Totally 40 houses were included in this study after screening for inclusion and exclusion criteria. Majority of the study participants were female (82.5%) and between the age of 41-50 (22.5%) or 51-60 (27.5%). The educational qualifications of the personnel surveyed are as follows, 2 (5%) have no formal schooling, 9 (22.5%) have primary schooling, 22 (55%) people have a high school education, 5 (12.5%) have completed higher secondary, and 2 (5%) have completed graduate or higher.

The distribution of monthly income of the interviewed personnel are as follows most people have an income range between 5000-9999 being 24 (60%), 6 (15%) have an income range of 10000-14999, 1 (2.5%) has an income range of 15000-19999, 5 (12.5%) have an income range of 20000-24999 and 4 (10%) have an income of more than 24999. The number of family members is hugely varied three families (7.5%) have one person in the family, 13 families (32.5%) have two people, 13 families (32.5%) have three people, four families have (10%) have four people and seven families (17.5%) have more than four people. The per capita income of the households are as follows, 23 (57.5%) of households fall between 1000-2500, 12 (30%) of households belong to 2501-5000, 3 (7.5%) households fall between 5001-10000 and 2 (5%) households have a per capita of greater than 10000 (Table 1).
Table 1: Distribution of socio-demographic details of study participants

| Variables                     | Assessment of demographic details |
|-------------------------------|-----------------------------------|
| Gender                        | Male : Female ratio 1:1.43         |
| Age                           | 21-30 1 (2.5%)                    |
|                               | 31-40 7 (17.5%)                   |
|                               | 41-50 9 (22.5%)                   |
|                               | 51-60 11 (27.5%)                  |
|                               | 61-70 8 (20%)                     |
|                               | >70 4 (10%)                       |
| Educational qualifications    | No formal education 2 (5%)        |
|                               | Primary schooling 9 (22.5%)       |
|                               | High school 22 (55%)              |
|                               | Higher secondary school 5 (12.5%) |
|                               | Graduate and above 2 (5%)         |
| Monthly income                | 5000-9999 24 (60%)                |
|                               | 10000-14999 6 (15%)               |
|                               | 15000-19999 1 (2.5%)              |
|                               | 20000-24999 5 (12.5%)             |
|                               | >25000 4 (10%)                    |
| Number of family members      | 1 3 (7.5%)                        |
|                               | 2 13 (32.5%)                      |
|                               | 3 13 (32.5%)                      |
|                               | 4 4 (10%)                         |
|                               | >4 7 (17.5%)                      |
| Per capita income             | 1000-2500 23 (57.5%)              |
|                               | 2501-5000 12 (30%)                |
|                               | 5001-10000 3 (7.5%)               |
|                               | >10000 2 (5%)                     |

Figure 1: Distribution of breeding spots

Assessment of environmental factors of household

The type of floor in most houses is mostly divided into Hard floor and Earth floor. There are 18 (45%) living on a hard floor and 22 (55%) living on Earth floor. All families involved in the study are living on the ground floor. There are some houses with a second floor mainly used a roof to keep water tanks. The source of water is a tube well/bore pipe for 17 (42.5%) families, 1 (2.5%) using pond/stream and a large majority using public standpipe being 22 (55%). 33 (82.5%) of the houses have an open yard, and seven families (17.5%) lack an open yard. 29 (72.5%) of houses have bushes in the vicinity, and 11 (27.5%) do not have bushes in the area. The number of windows varies in the area. 15 (37.5%) of houses have one window, 18 (45%) of houses have two windows, 5 (12.5%) of houses have three win-
Table 2: Assessment of environmental characteristics of study participants

| Variables                             | Assessment of Ecological factors |
|---------------------------------------|----------------------------------|
| Type of floor                          |                                  |
| Hard floor                            | 22 (55%)                         |
| Earth floor                           | 18 (45%)                         |
| Type of wall                           |                                  |
| Cement brick                          | 40 (100%)                        |
| The floor of the principal living     |                                  |
| Ground floor                          | 40 (100%)                        |
| Yard/open space                       |                                  |
| Yes                                   | 33 (82.5%)                       |
| No                                    | 7 (17.5%)                        |
| Bushes in yard                        |                                  |
| Yes                                   | 29 (72.5%)                       |
| No                                    | 11 (17.5%)                       |
| No. of windows                        |                                  |
| 1                                     | 15 (37.5%)                       |
| 2                                     | 18 (45%)                         |
| 3                                     | 5 (12.5%)                        |
| 4                                     | 2 (5%)                           |
| Source of your drinking water         |                                  |
| Pond/stream                           | 1 (2.5%)                         |
| Public stand pipe                     | 22 (55%)                         |
| Tube well/bore hole                   | 17 (42.5%)                       |
| Source of water for domestic usage    |                                  |
| Pond/stream                           | 1 (2.5%)                         |
| Public stand pipe                     | 22 (55%)                         |
| Tube well/bore hole                   | 17 (42.5%)                       |
| Type of toilet facilities with or without a septic tank | 40 (100%) |
| Method of disposal of liquid waste    |                                  |
| Let to the garden                     | 17 (42.5%)                       |
| Open ground                           | 18 (45%)                         |
| A closed pipe drainage system         | 1 (2.5%)                         |
| Underground drainage                  | 4 (10%)                          |
| Method of water storage               |                                  |
| Open tank                             | 14 (35%)                         |
| Closed tank                           | 26 (65%)                         |
| Method of disposal of solid waste     |                                  |
| Dumped in open ground                 | 22 (55%)                         |
| Burnt in the open area                | 3 (7.5%)                         |
| Collected and disposed of by munici-   | 15 (37.5%)                       |
| pality/panchayat                      |                                  |
| Availability of Cattle                |                                  |
| Yes                                   | 7 (17.5%)                        |
| No                                    | 33 (82.5%)                       |

dows, and a small percentage 2 (5%) of houses have four windows or more. All houses in the area have flush to a piped sewage system. The method of disposal of liquid waste differs significantly. Eighteen families (45%) dispose of in open gardens, 17 families (42.5%) just let it into the garden, one family (2.5%) use open pipe drainage system/closed pipe drainage system and four families (10%) use underground drainage system. The method for water storage was found to be open tanks in 26 (65%) and 14 (35%) in closed tanks. The method of solid waste disposal is dived into three categories dumped in open ground, burnt in the open area and collected and disposed of by municipality or panchayat. 22 (55%) families dumped solid waste in open ground, 15 (37.5%) families solid waste was collected and disposed of by municipality or panchayat and 3 (7.5%) families of solid waste was burnt. All households consist of a toilet with a septic tank. 7 (17.5%) of households have cattle such as cows, chickens, etc. 33 (82.5%) of households do not have any cattle (Table 2).

Assessment of potential breeding sources

Next, the results of the breeding sites and mosquito infestation was compiled. In-water storage tanks, there was neither mosquito nor larva breeding (0%)
Table 3: Assessment of potential breeding sources

| Variables                        | Mosquito absent, Larva absent | Mosquito present, Larva absent | Mosquito present, Larva present |
|---------------------------------|------------------------------|--------------------------------|---------------------------------|
| Water storage tank              | N (%) 40 (100%)              | N (%) 0 (0%)                   | N (%) 0 (0%)                    |
| Drum                            | N (%) 39 (97.5%)              | N (%) 1 (2.5%)                 | N (%) 0 (0%)                    |
| Air cooler                       | N (%) 28 (70%)                | N (%) 5 (12.5%)                | N (%) 7 (17.5%)                 |
| Used tires                       | N (%) 40 (100%)               | N (%) 0 (0%)                   | N (%) 0 (0%)                    |
| Flower vase with water           | N (%) 40 (100%)               | N (%) 0 (0%)                   | N (%) 0 (0%)                    |
| Roof gutter/sun shades           | N (%) 29 (72.5%)              | N (%) 3 (7.5%)                 | N (%) 8 (20%)                   |
| Potted plants with saucer        | N (%) 40 (100%)               | N (%) 0 (0%)                   | N (%) 0 (0%)                    |
| Ornamental pool/fountain         | N (%) 40 (100%)               | N (%) 0 (0%)                   | N (%) 0 (0%)                    |
| Animal water container           | N (%) 40 (100%)               | N (%) 0 (0%)                   | N (%) 0 (0%)                    |
| Discarded junks                  | N (%) 25 (62.5%)              | N (%) 7 (17.5%)                | N (%) 8 (20%)                   |
| Discarded food & drink containers | N (%) 23 (57.5%)             | N (%) 13 (32.5%)               | N (%) 4 (10%)                   |
| Disposable cups/glasses          | N (%) 17 (42.5%)              | N (%) 23 (57.5%)               | N (%) 0 (0%)                    |
| Tree holes                       | N (%) 38 (95%)                | N (%) 2 (5%)                   | N (%) 0 (0%)                    |
| Rock holes                       | N (%) 39 (97.5%)              | N (%) 1 (2.5%)                 | N (%) 0 (0%)                    |
| Fruit shell                      | N (%) 38 (95%)                | N (%) 2 (5%)                   | N (%) 0 (0%)                    |
| Shoot off palm/ coconut leaves   | N (%) 40 (100%)               | N (%) 0 (0%)                   | N (%) 0 (0%)                    |

Distribution of breeding spots

The map depicts the number of households where breeding spots are present or absent. The red dots represent the households with breeding spots present, and the green spots represent the households without any breeding spots (Figure 1). There are 11 (27.5%) of households without any breeding spots and 29 (72.5%) of households with breeding spots.

Distribution of breeding spots

The graph depicts the distribution of the various breeding spots. Air cooler, tree holes, fruit shells and rock holes are seen only in 1 (2.5%) household. The most commonly seen breeding spot is disposable cups which is seen in 23 (57.5%) households. The next most common is discarded food containers which are seen in 17 (42.5%) households, followed by discarded junk which is seen in 15 (37.5%) households (Graph 1).

DISCUSSION

As mentioned by Arboleda, S et al. (2009), artificial containers are a significant breeding spot for dengue...
mosquitos. This is similar to the data obtained by us as there is a clear majority of households where artificial containers such as discarded junk (37.5%), discarded food containers (42.5%) and disposable cups (57.5%) account for most of the breeding spots. This can be attributed to the low socio-economic status and education background of the individuals in the vicinity. They lack the proper knowledge and practices to prevent the breeding of mosquito in their households. A proper campaigning and knowledge sharing session will benefit the people of the area by decreasing the possibility of mosquito infestation and in turn, decrease the cases of dengue in that area. (Getachew et al., 2015) further emphasize on the storage of water in containers such as the drum is due to the irregular supply and stockpiling of water for future use. When this water is left unattended for long periods leads to potential mosquito breeding as seen in our study where there is a good number of households (30%) where mosquito breeding was seen in the drums. As mentioned by (Bhat and Krishnamoorthy, 2014) who associated insufficient rainfall and long-term storage of water in containers, it further proves evidence to the fact that stockpiling water over a long period can be attributed to an elevated risk of dengue infestation.

(Snr et al., 2011) and (Bhat and Krishnamoorthy, 2014) stress the importance of removing water-filled containers kept over a while as a manner to eliminate mosquito breeding. (Philbert and Ijumba, 2013; Hiscox et al., 2013) suggest that the proper coving of water-holding containers is a very good practice to prevent stagnant water retention and mosquito breeding. (Snr et al., 2011; Bhat and Krishnamoorthy, 2014; Thete and Shinde, 2013) greatly emphasize on the need of both awareness and knowledge of the residents on dengue mosquito breeding. This can be implemented by conducting a public health education to increase awareness and highlight the seriousness of mosquito breeding and diseases associated with it. By slowly reducing various ecological and household factors associated with mosquito breeding, we can reduce the risk of dengue infection ultimately.

CONCLUSIONS

In the area of Mappedu, we can identify the potential mosquito breeding in various households. The lack of knowledge and awareness is a crucial factor that has contributed to the identification of potential breeding spots. Prolonged water storage without proper covers can also be attributed as a critical factor in the potential breeding spots. We have mapped out the potential risky households with a variety of factors indicating the danger that these households could face. These breeding spots are not only potential risky spots for dengue but also other mosquito-borne diseases such as malaria. A detailed and simple awareness and health program can help in the long run in the fight against dengue.

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Conflict of interest

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