Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/7nfbzx92

ENVIRONMENTAL RISK MAPPING FOR DENGUE TRANSMISSION AND PREVENTIVE PRACTICES IN AN URBAN AREA OF PUDUCHERRY

Dr. Sumedha. K[1*], Dr. Velavan. A[2], Dr. Anil J Purty[3]

[1*]Assistant Professor, Department of Community Medicine, Melmaruvathur Adhiparasakthi Institute of Medical Sciences and Research, MGR University.
[2] Associate Professor, Department of Community Medicine, Pondicherry Institute of Medical Sciences, Pondicherry University.
[3]Professor, Department of Community Medicine, Pondicherry Institute of Medical Sciences, Pondicherry University.

[*]**Corresponding Author:** Dr. Sumedha.K
*Melmaruvathur Adhiparasakthi Institute of Medical Sciences, Melmaruvathur – 603319, Tamil Nadu, India. Cell No. +919600291792, Mail ID: sumedhakesavan@gmail.com, Institute Ph. No.: +91 044 – 27528302

Introduction:

A diverse group of diseases caused by a variety of microorganisms including viruses, bacteria and parasites that grow in the hot and humid climate of tropics and having different modes of transmission are called the "Neglected Tropical Diseases" (NTD). More than a billion people across the world, mostly living in the low- and lower-middle- income countries, are affected by the NTDs. Among six WHO regions, South-East Asia Region bears the second highest burden of these debilitating infections and at least one NTD is endemic in each of the Member States of the region [1].

Dengue is one such NTD, a mosquito borne viral disease which is of four serotypes (DEN-1, DEN-2, DEN-3 and DEN-4). It is an acute febrile disease transmitted by the bite of an Aedes mosquito infected with any one of the four dengue viruses. The virus is primarily transmitted by female Aedes aegypti mosquito and to a lesser extent by Aedes albopictus mosquito [1].

The transmission of the virus to humans is through the bites of infected female mosquitoes. After virus enters the human body, the incubation will take place for 4–10 days. An infected mosquito is capable of transmitting the virus for the rest of its life [2].

Dengue Haemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS), has emerged as a great public health concern, spreading to all tropical and subtropical countries in the world. The global incidence of dengue has grown dramatically in recent decades. An estimated 2.5 billion people in more than 100 countries are at-risk and an estimated 390 million dengue infections occur annually in the world. It is of particular importance in South East Asia, which bear high burden of dengue [1, 2].

As per National Vector Borne Disease Control Programme (NVBDCP), in India, a surge was found in the incidence of Dengue cases from 28292 in the year 2010 to 129166 in the year 2016.Puducherry reported a total of 342 dengue cases in the year 2016(Source: NVBDCP Programme office Puducherry).

Changing trends in human ecology, demography and globalization, associated with climate change is attributable to increasing incidence, severity and frequency of dengue epidemics. A complex interaction between the virus, the host and the vector can be influenced by various factors such as socio-demographic changes, explosive population growth, improper town planning, uncontrolled urbanization, poor control of water stagnation and the vector for disease transmission. Also increased international travel to endemic areas either for recreational, business or for military purposes and inadequate public health infrastructure in the developing countries are also the important factors that would describe the swift geographical spread of the disease [3, 4]. The infected female Aedes mosquitoes which are responsible for the transmission of dengue are also the main vectors for many other globally consequential arbo-viruses. *Ae. aegypti* is at present disseminated in densely populated urban areas and habitually breeds in indoor and outdoor environment in a wide range of natural and artificial water-holding containers like plastic and cement water storage tanks, leaves, water storage jars and drums, flower vases, curing tanks, glasses, rubber tyres, and plastic bottles. In urban areas, the potential breeding sources of the mosquito larvae emerge predominantly from abandoned areas of construction sites and stagnated water collections that can create advantageous circumstances for mosquitoes to breed [5-9].

The knocking down of *Aedes* mosquitoes breeding sites is a key intervention to reduce larval occurrence, also in addition the propagation of adult mosquito population and arboviral transmission. A strong commitment from global community is important to tackle the reversing trend of dengue. The integral part of achieving effective dengue prevention and control include: diagnosis and case management; integrated surveillance and outbreak preparedness; sustainable vector control with integrated vector management approach; and research [10]. The objective to decrease dengue burden can only be accomplished with several enabling factors for implementation, including advocacy and resource mobilization; partnership, co-ordination and collaboration; optimal community participation through communication strategy for behavioral outcomes; capacity building and adequate monitoring and evaluation [10]. Though various studies have been done across the country, in-order to identify the risk factors for dengue transmission, we carried out this study in our field practice area, Solai Nagar, Muthialpet, Puducherry where there are incidences of dengue cases been reported. Hence the study was conducted to map the environmental risk factors prevailing in the area in-order to estimate the existing the risk for dengue transmission and also to assess the understanding about the disease among the residents of the study area.

The aim of the study was to determine the risk factors for dengue transmission and preventive practices followed for the disease by the population residing in Urban Puducherry.

The objectives were;

- To determine the household and environmental risk factors for dengue transmission in an urban area in Puducherry.
- To assess the knowledge, attitude and preventive practices regarding dengue among the respondents in the study area.

Materials and Methods

Study design and study setting: A community based cross – sectional study was conducted among all the adult individuals aged 18 and above, who were the permanent residents of Solai Nagar, Muthialpet, field practice area of PIMS (Pondicherry Institute of Medical Sciences) City Centre/Urban Health Centre located in Pakamudiyanpet, in the district of Puducherry, India from August 2018– March 2019 after obtaining the Institute Ethics Committee approval (IEC No: RC/17/63). The study area consisted of about 958 households with a total population of 3731, total males are 1841, females are 1890, including elderly population of 394 and under-five of 203 with the availability of Govt. PHC health facility within 1.5 Kms. Majority of the people in the study area were involved in semi-skilled work and work as fisherman, carpenters, construction workers, house painters, plumbers and electricians.

Sample size: The minimum required sample was calculated to be 577 based on the study done by Jeelani et al [9], which reported house index of 16% and relative precision of 20% (with nonresponse rate of 10%) . However we were able to cover a total sample of 597 households.
Sampling technique: Field practice area of Urban Health Centre, Muthialpet, constitutes four divisions A, B C and D with a total population of 11924. B division which comprises Solai Nagar was selected by simple random sampling for conducting the study. The Solai Nagar area had 958 households. The list of all households in the area was made with street names and house numbers. The required number of households was selected randomly and one individual aged 18 years and above from each household were interviewed and their household was inspected for the potential breeding sources of the Aedes larvae. In case of non- availability of eligible individuals or if the houses were kept locked at the time of first visit, a re-visit was made.
Data collection method: A house to house survey was carried out in the study area. The study participants from each household were interviewed regarding socio-demographic characteristics and preventive practices against dengue transmission using a structured questionnaire. An assessment of housing conditions and for the presence of potential larval breeding sites was done. In the survey GIS coordinates of location of houses, and other potential breeding sites were noted. Mobile phone was used for marking the latitude and longitude values of the locations and Arc GIS 10.7 software was used for mapping and for this purpose, the help of Vector Control Research Centre (VCRC), Puducherry was taken to plot the potential breeding sites in the map. During the survey, health education on various aspects of dengue such as knowledge about dengue disease, its vectors and its prevention was given to the study population using IEC tools at the first contact. After the survey is completed, a report on identified risk factors would be submitted to National Vector Borne Disease Control Programme office for appropriate remedial measures.
Statistical Analysis: The data was entered in Microsoft Excel 2013 and data analyzed using Statistical Package for the Social Sciences for Windows (SPSS) version 20.0.Arc GIS 10.7 software was used for mapping of the prevailing potential breeding sources in the households. Outcome variables were expressed as percentages and proportions.

Results:
Out of 597 study participants, 289 (48.4%) belonged to the age group of 31- 50 years, most of study participants were females 514 (86%), 243(40.7%) participants were educated up-to high school, with majority of them 502 (84.1%) being married, house wives 423 (70.9%) and belonging to a socio economic class II 242 (40.5%) as per modified BG Prasad's classification. Table 1 demonstrates the distribution of study participants based on their socio – demographic details.

Table 1: Distribution of Study Participants Based on their Socio-demographic Details (n=597)

Demographic details	**n (%)**
Age (years)	
18 – 30	122(20.4)
31 – 50	289(48.4)
51 – 70	142(23.8)
>70	44(7.4)
Gender	
Male	83(14)
Female	514 (86)
Education	
No formal education	59(9.9)
Primary school	96(16.1)
High school	243(40.7)
Higher secondary	91(15.2)
Graduate & above	108(18.1)
Occupation	

Employed	105(17.6)
Unemployed	34(5.7)
House wife	423(70.9)
Others	35(5.8)
Marital Status	
Married	502(84.1)
Unmarried	39(6.5)
Others	56(9.4)
SES	
Class I	91(15.2)
Class II	242(40.5)
Class III	139(23.3)
Class IV	106(17.8)
Class V	19(3.2)

Maximum number of participants 589 (98.7%) lived in houses with hard floor. Most of the study participants'580(97.2%) household wall type were with cement brick. 500(83.8%) participants lived in the house with 1-5 windows. Majority of the study participants 496 (83%) did not have yard/bushes in their households. Source of water for drinking and domestic usage for majority of the study participants 489(81.9%) and 591 (99%) respectively was piped water through house connection. Majority of the study participants 519(86.9%) stored the water for domestic purpose in closed tanks. Most of the study participants 535(89.7%) have flush to pipe sewage system type of toilet facility. Very few participants 4(0.7%) of the participants had cattle at home. Solid waste disposal by majority of the participants 533(89.3%) was through collection and disposal by municipality. 522(87.5%) dispose their liquid waste by underground drainage. Out of 597 study participants, 19(3.2%) of them had the history of dengue fever in the past one year. Table 2 demonstrates the distribution of study participants based on their household environmental characteristics.

Table 2: Distribution of Study Participants Based on their Household Environmental Characteristics (n = 597)

Sl.No	Environmental Characteristics	n(%)
1.	**Housing Condition**	
	Type of Floor	
	Hard floor	587(98.7)
	Earth floor	8(1.3)
	Type of Wall	
	Cement brick	580(97.2)
	Thatch	14(2.3)
	Plastic sheet	1(0.2)
	Metal sheet	2(0.3)
	No. of Windows	
	0	15(2.5)
	1-5	500(83.8)
	5-10	81(13.6)
	>10	1(0.2)
2.	**Presence of Yard/Bushes**	
	Yes	101(17)
	No	496(83)
3.	**Source of Drinking Water**	
	Piped water through house connection	489(81.9)

	Public standpipe	2(0.3)
	Protected tube well or bore well	1(0.2)
	Packed water	105(17.6)
4.	**Source of Water for Domestic Purpose**	
	Piped water through house connection	591(99)
	Public standpipe	5(0.8)
	Protected tube well or bore well	1(0.2)
5.	**Water Storage for Domestic Purpose**	
	Open Tanks	5(0.8)
	Closed Tanks	519(86.9)
	No Tanks	73(12.3)
6.	**Availability of Toilet**	
	Flush to pipe sewage system	535(89.7)
	Flush to septic tank sewage system	36(6.0)
	Public/ community toilet	24(4.0)
	No facilities (open defecation)	2(0.3)
7.	**Cattle in Household**	
	Yes	4(0.7)
	No	593(99.3)
8.	**Disposal of Solid Waste**	
	Dumped on the open ground	62(10.4)
	Burnt in the open space	2(0.3)
	Collected and disposed by municipality	533(89.3)
9.	**Disposal of Liquid Waste**	
	Let to open ground	49(8.2)
	Let to garden	9(1.5)
	Underground drainage	522(87.5)
	Open drainage system	17(2.8)

The most commonly found potential breeding sources were discarded junks (3745), sunshades/ roof gutters (1921), shoot off palm/ coconut leaves (611), fruit shells (597) and flower vases with water (409). The more commonly found potential breeding sources in most of the houses were water storage tanks in 524 (87.8%) houses, sun shades/ roof gutter in 510 (85.4%) houses and flower vases with water in 373 (62.4%). Figure 1 depicts the distribution of households with potential breeding sources.

Figure 1: Distribution of households with potential breeding sources (n=597)

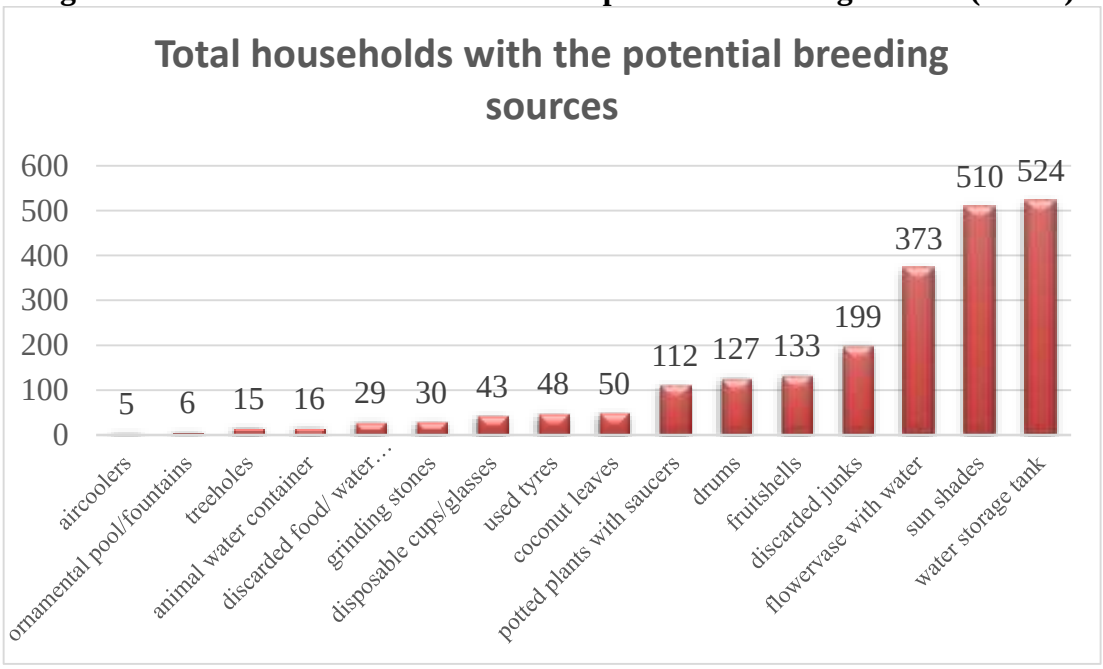

Figure 2: Illustration of the households with combined potential breeding sites in the study area. [Courtesy VCRC (ICMR), Puducherry]

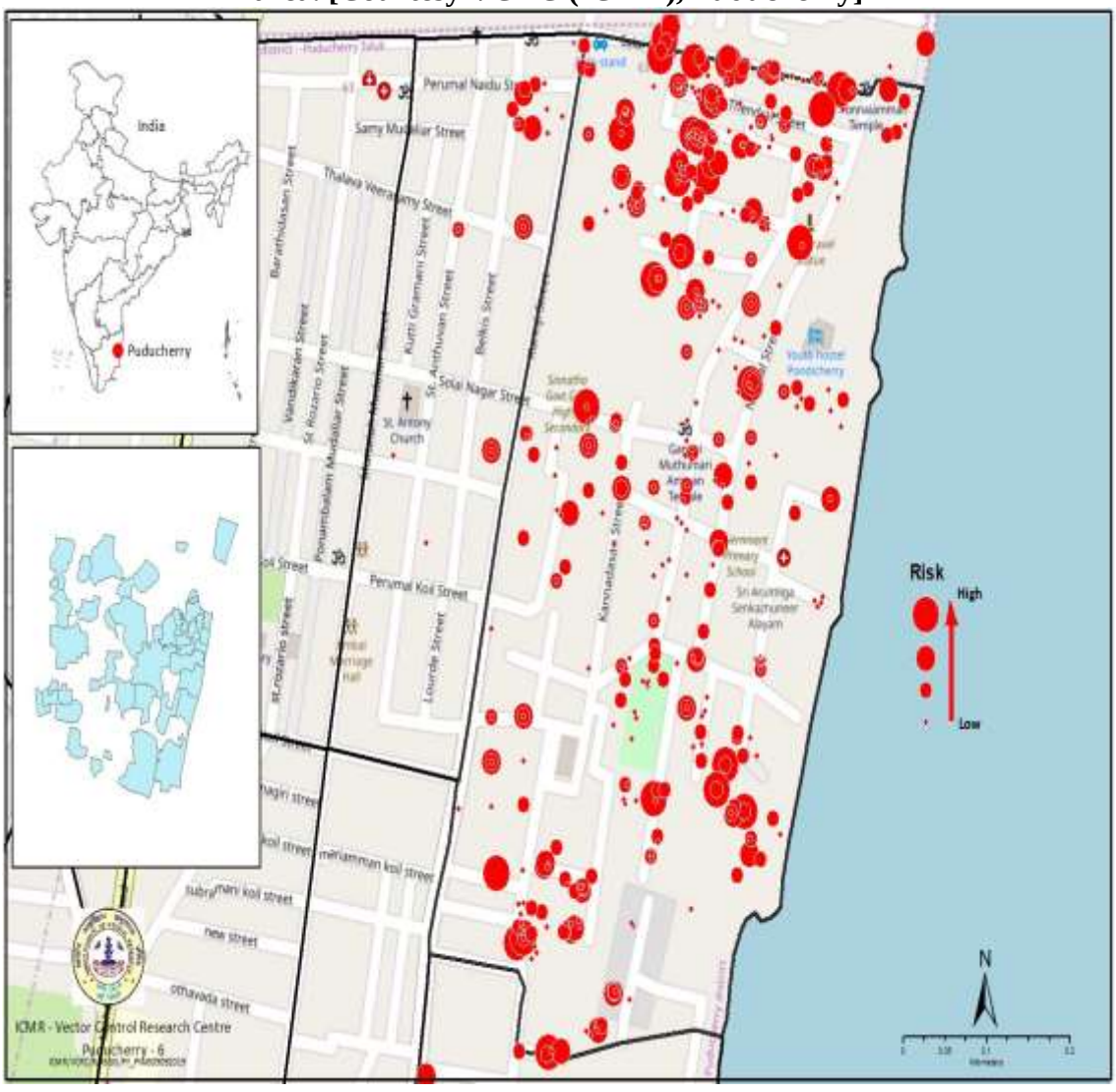

Figure 2 illustrates the map depicting distribution of households where combined risk of potential breeding sites was present. Bigger dots represents the households with higher risk with many potential breeding sources while smaller dots represents the households with lower risk with lesser number of potential breeding sources. Hence it is observed that houses located in Salai Street, Thendral Street, Mullai Street, Neithal Street and Tsunami quarters in the study area are at higher risk of dengue as there is huge concentration of potential breeding sites.

Majority of the study participants were aware that fever 584 (97.8%), headache 548 (91.8%) joint pain 553 (92.6%) and muscle pain 548 (91.8%) are the symptoms of dengue disease. However more than half of the study participants were not aware that pain behind the eye 319 (53.4%), rash 327 (54.8%) and abdominal pain 366 (61.3%) are also the symptoms of dengue disease. Most of the study participants were aware that dengue fever is transmitted by Aedes mosquito 503 (84.3%), also many of them were aware that dengue fever can be transmitted by blood transfusion 288 (48.2%) and by needle stick 279 (46.7%). However more than 80 percent of them considered that person to person contact can also transmit dengue. A total of 261(43.7%) study participants knew that dengue mosquitoes likely to feed during day time. Most of the study participants were aware that dengue mosquitoes breed in standing water 581 (97.3%) and clean water 388 (65%). Majority were aware of control measures for dengue fever such as use of window screens and bed nets 560 (93.8%), insecticidal sprays 462 (77.4%), covering water containers 582 (97.5%), mosquito repellent 431 (72.2%) and cutting down bushes 580 (97.2%). However participants felt that mosquito repellents 127 (21.3%) are not an effective method and 133 (22.3%) participants did not know that pouring chemicals in standing water can kill the larvae. Majority of the study participants felt that plenty of rest 478 (80.1%), drinking plenty of water 436 (73%), consulting a physician 590 (98.8%) is important in managing dengue. Majority of the study participants 394(66%) agreed that dengue fever is a serious illness, 319(53.4 %) of the study participants agreed that they are at a risk of getting dengue fever, 518(86.8 %) agreed that visiting a doctor is important if they have symptoms of dengue fever, 524 (87.8%) of the study participants agreed that keeping surroundings clean is essential to prevent dengue and majority of the study participants 510 (85.4%) agreed that personal protective measures like repellents, bed nets, window screens are important to prevent dengue fever. About 97 study participants either strongly disagreed or not sure that they are at a risk of getting dengue fever. Use of mosquito coils/ repellents 333 (55.8%) was the only common method practiced to prevent mosquito bite while 237(39.7%) of the study participants did nothing to reduce the mosquitoes menace. Most of the study participants 571(95.6%) responded that the water containers in their house were well covered also 572 (95.8%) of the participants responded that they will clean the water filled containers and ditches in and around their house always. The source of information regarding dengue fever for most of the study participants was through television/ radio 570(95.4%) followed by public announcements through loud speaker 92(15.4%). Table 3 demonstrates the knowledge, attitude and preventive practices regarding dengue fever among the study participants.

Table 3: Knowledge attitude and preventive practices regarding dengue fever among the study participants (n=597)

Sl. No.	Item	Knowledge Status	
		Adequate n (%)	Inadequate n (%)
1.	Knowledge regarding symptoms of dengue	349(58.5)	248(41.5)
2.	Knowledge regarding mode of transmission	392(65.7)	205(34.3)
3.	Knowledge regarding biting habits of Aedes mosquito	261(43.7)	336(56.3)
4.	Knowledge regarding breeding sites	485(81.2)	112(18.8)
5.	Knowledge regarding control measures	511(85.6)	86(14.4)
6.	Knowledge regarding management of dengue	447(74.9)	150(25.1)

Sl. No.	Item	Attitude Status	
		Positive n (%)	Negative n (%)
1.	Attitude towards dengue fever and management	480(80.4)	117(19.6)
2.	Attitude towards prevention and protective measures of dengue	568(95.1)	29(4.9)
Sl. No.	**Item**	**Preventive practices**	
		Adequate n (%)	**Inadequate n (%)**
1.	Preventing mosquito man contact	105 (17.6)	492 (82.4)
2.	Eliminating mosquito breeding sites	573 (96)	24(4)

Discussion:

A community based cross sectional study was carried out in Solai Nagar, Muthialpet, field practice area of Urban Health Centre, Pakamudiyampet. Study area consisted of 950 households and a total population of 3731 individuals and it is located coastally and most of them were fishermen and daily wage labourers. In this study, a total 597 households were surveyed for assessment of household environment in this area and one adult individual available in the house at the time of survey was interviewed regarding socio-demographic characteristics and preventive practices against dengue transmission using a structured questionnaire from August 2018 to March 2019.

In common the housing conditions of the participants in our study were good with almost more than 98% of people residing in pukka houses. Almost 96% of the households utilized very own sanitary latrines and the practice of open defecation in this area were found to be nil. Method of disposal of liquid waste followed by majority of household was through underground drainage while most of the participants responded that solid waste was collected and disposed through municipality. Studies have shown that housing conditions play a major role in regulating the transmission of dengue fever. It was reported that the risk of getting dengue fever was attributed to poor housing conditions and improper waste disposal [11]. However in the present study, housing conditions were not conducive to the risk of dengue transmission.

A total 86.9% of the study participants responded that they stored the water for the domestic purposes in closed tanks where as 12% of them responded as no water storage tanks were present at the household level and stored water in open drums or pots. It was disclosed in a study that in areas which suffer irregular water supply, individuals tend to store water in open barrels, drums and mud pots in turn acting as a breeding source of Aedes larvae [12].

On assessing the vector breeding sites, it was found that a total of 9,000 potential breeding sources which had the capacity for water holding were present in the study area during the time of survey. 91.7 percent of houses had at least one potential breeding site. As the study area where the survey was conducted was located coastally and having residents more commonly with fishing as their prime occupation for living, discarded junks were found to be the most abundant type of potential breeding sources followed by sunshades/ roof gutters, coconut leaves, fruit shells, flower vases with water, and open drums. Sunshades which are improperly constructed and prone to stagnate water are considered to be the potential breeding sites. Most of the containers were found to have water during data collection. Two breeding sources (0.02%) had mosquito larvae, of which one was a mud pot which contained the Aedes aegypti larvae and the other was a tree hole which had the larvae of Armigeres subalbatus.

Most of the dwellers of the study area stored the municipal water either in the overhead tanks or open drums (both indoor and outdoor) as the municipal water supply is not guaranteed all the time. It was found that a high proportion of houses had water storage tanks and many houses had open drums for water storage. These overhead tanks and drums were bigger in size and hold a huge volume of water. Water which is stored in these containers is seldom evacuated or refilled periodically. A study done in Rio de Janeiro revealed that open-mouthed and large containers are the most capable for larval propagation [13]. Also, most of the times, containers outdoors and on

rooftops are frequently not well closed, every so often unwittingly permitting them to collect rainwater and, thus, creating them as undying breeding sources for *Aedes* mosquitoes [14].

Also, the natural vector breeding sites such as tree holes, coconut leaves/ shoot off palm and fruit shells were seen in almost 33 percent of houses. The existence of such water-holding containers permits *Aedes* mosquito larvae to procreate, thus leading to the expansion of the *Aedes* mosquito population and the associated risk for arbovirus transmission. This was found inconsistent with the results of other studies where the predominant risk factor for larval breeding was plenty of coconut shells around the houses (73%), containers without covers in and around the houses (70.8%), the most productive larval breeding sites were found to be the open, neglected water containers under the shady places [15,16].

According to the observations made from the GIS mapping of the potential breeding sites of the mosquito larvae present in the study area, it was found that most of the potential breeding sites were highly concentrated in some areas like Salai Street, Thendral Street, Mullai Street, Neithal Street and Tsunami quarters. Also majority of the study participants residing in these localities were found to be fisherman by occupation and tend to store many discarded junks which were used for fishing in and around their households.

The understanding about the disease dengue with regards to knowledge on symptoms, transmission, vector breeding habitats, control measures, management, attitude towards the disease and preventive practices followed was also assessed among the study participants.

It was found that majority of the participants were able to correctly identify that fever, headache, muscle and joint pain as symptoms of dengue though most of the study participants were not able to rightly say that rash, pain behind the eye and abdominal pain are also the symptoms of dengue. Also the study revealed that majority of the participants (> 85%) were aware that dengue is transmitted by Aedes mosquito and most of them were able to recognize that dengue can be transmitted by blood transfusion and needle stick. About 44 percent of them were able point out that the dengue mosquitoes likely to feed during the day time. With regards to breeding habits, most of them were able to identify that dengue mosquitoes breed in standing and clean water. About knowledge regarding control measures for dengue fever, most of them were able rightly say that window screen and bed nets, covering water containers and pouring chemicals in the standing water can reduce the mosquitoes. When enquired about management of dengue, almost all the study participants felt that consulting a physician is essential for sudden onset of fever with chills, headache and pain behind the eye. The results of this study exhibited that the respondents had knowledge of the concepts of dengue and this was found to be in consistent with many previous studies [17-19]. The source of information regarding dengue fever was found to be through television/ radio followed by loud speaker announcements, newspaper and from health workers. This was found in consistent with other studies where TV/ radio were the most common source of information regarding dengue while few respondents mentioned schools and health workers as the source of information [17, 18]. Adequate knowledge about the Aedes vector and signs and symptoms of dengue is crucial in recognizing the disease and in perusing early and proper medical attention to save lives.

While assessing the attitude towards the disease among the study participants, it was found that, more than 85 percent of the respondents agreed that keeping the surroundings clean is essential to prevent dengue, visiting a doctor is important if symptoms suggestive of dengue is present and personal protective measures like using repellents, bed nets, window screens are important to prevent dengue fever. Majority them agreed that dengue is a serious illness and they are at a risk of getting dengue fever. Majority of the study participants had adequate knowledge about the disease and attitude towards the disease was considerably good, the translation of knowledge into practices were found to be low. The study revealed that 40 percent of the households did not use any type of preventive measure to reduce the mosquitoes while 55.8 percent were using mosquito coils/ repellents to prevent mosquitoes. Also when enquired about the other proven methods for prevention of mosquito man contact less than 10 percent of them were found to be following those such as usage of insecticidal spray, professional pest control, window screens and bed nets, wearing full sleeve cloths and cutting down bushes in the yard regularly. Studies have shown similar results

such as less than 40% of households only used at least one type of protective measures against dengue and most commonly used protective measures were mosquito coil or repellents in living room and traditional neem leaf burning while 14% of them used bed nets and 7% used window screens [19,20].

Practices regarding elimination of the breeding site of mosquitoes was also assessed, more than 95 percent of the study participants responded that the water containers in their houses are well covered and they would clean the water filled containers and ditches in and around their houses always. Though the responses were found to be in the support of elimination of the mosquito breeding sites in and around their houses, on observations made as discussed before, about 91.7% of houses were having at least one potential breeding source for the mosquito larvae.

This implies that the study area had all types of potential breeding sites and is at high risk of transmitting dengue fever easily. Though the knowledge regarding dengue fever was found to be adequate there was a gap in implementing the preventive practices for the same in real life situation. Hence a full-fledged intervention is required in the study area to remove the potential breeding sites and educate the people on dengue.

Limitations:

Majority of the study participants were females during the survey which could have affected the assessment of knowledge, attitude and preventive practices done among the study participants. Since the study was done in a very small area, the results may not be applicable to all the urban areas of Puducherry.

Conclusion:

The study area had all types of potential breeding sites like discarded junks, improperly constructed sunshades/ roof gutters, coconut leaves, fruit shells, flower vases with water, and open drums and is at a high risk of transmitting dengue fever easily. Though the knowledge regarding dengue fever was found to be adequate among the study participants, there was a gap in implementing the preventive practices for the same. Hence a full-fledged intervention is required in the study area to remove the potential breeding sites and behavioral change communication must be given to the residents on dengue prevention.

References:

1. Neglected tropical diseases [Internet]. South-East Asia Regional Office. 2019 [cited9October2019].Availablefrom:http://www.searo.who.int/entity/vector_borne_tropical_diseases/en/
2. Neglected T. PAHO WHO | Dengue | Epidemiological alerts and updates [Internet].Paho.org.2019.Availablefrom:https://www.paho.org/hq/index.php?option=com_topics&view=rdmore&cid=2217&Itemid=40734&lang=en
3. WHO Western Pacific World Health Organization [Internet].Who.int.2019. Available from: https://www.who.int/westernpacific
4. WHO | DengueNet Implementation in the Americas. Report of a WHO/PAHO/CDC Meeting, San Juan, Puerto Rico, 9-11 July 2002 [Internet]. Who.int. 2002 [cited 9 August 2019]. Available from: https://www.who.int/csr/resources/publications/dengue/WHO_CDS_CSR_GAR_2003_8/en/
5. WHO updates fact sheet on Dengue and Severe dengue (15 April 2019) [Internet]. communitymedicine4asses. 2019 [cited 9 August 2019]. Available from: https://communitymedicine4asses.com/2019/04/17/who-updates-fact-sheet-on-dengue-and-severe-dengue/
6. [Internet]. Apps.who.int. 2019 [cited 9 October 2019]. Available from: https://apps.who.int/iris/bitstream/handle/10665/75303/9789241504034_eng.pdf;sequence=1
7. Succo T, Leparc-Goffart I, Ferré J, Roiz D, Broche B, Maquart M et al. Autochthonous dengue outbreak in Nîmes, South of France, July to September 2015. Eurosurveillance. 2016;21(21).

8. Locally Acquired Dengue --- Key West, Florida, 2009--2010 [Internet]. Cdc.gov. 2010 [cited 10 August 2019]. Available from: https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5919a1.htm
9. Gubler D, Clark G. Dengue/Dengue Hemorrhagic Fever: The Emergence of a Global Health Problem. Emerging Infectious Diseases. 1995;1(2):55-57.
10. Book Review: Disease Control Priorities in Developing Countries. Food and Nutrition Bulletin. 2006;27(4):357-357.
11. 74Thammapalo S, Chongsuvivatwong V, Geater A, Dueravee M. Environmental factors and incidence of dengue fever and dengue haemorrhagic fever in an urban area, Southern Thailand. Epidemiol Infection. 2008;136:135-43.
12. 76Andrea C, de Oliveira LJW, Pequeno MAC, Gondim CP, Paes LL, Johannes S. Irregular water supply, household usage and dengue: a bio-social study in the Brazilian Northeast. Cad. Saúde Pública. 2009;25(1):125-36
13. Maciel-de-Freitas R, Marques WA, Peres RC, et al. Variation in *Aedes* aegypti (Diptera: Culicidae) container productivity in a slum and a suburban district of Rio de Janeiro during dry and wet seasons. Mem Inst Oswaldo Cruz 2007; 102: 489–496
14. 75Strickman D, Kittayapong P. Dengue and its vectors in Thailand: calculated transmission risk from total pupal counts of *Aedes* aegypti and association of wing-length measurements with aspects of the larval habitat. Am J Trop Med Hyg 2003; 68: 209–217.
15. Pattanshetty S, Chandrasekaran V, Gupta R, Kamath R. Assessment of environmental factors associated with dengue transmission in Udupi Taluk, Karnataka. Journal of the Scientific Society. 2013;40(3):159.
16. Arunachalam N, Tyagi BK, Samuel M, Krishnamoorthi R, Manavalan R, Tewari SC, et al. Community-based control of Aedes aegypti by adoption of eco-health methods in Chennai City, India. Pathog Glob Health. 2012; 106: 488–496.
17. Labrague L, Yboa B. Dengue Knowledge and Preventive Practices among Rural Residents in Samar Province, Philippines. International Journal of Public Health Science (IJPHS). 2013;2(2).
18. 84TDR | Operational guide for assessing the productivity of Aedes aegypti breeding sites [Internet]. Who.int. 2011 [cited 11 October 2019]. Available from: https://www.who.int/tdr/publications/tdr-research-publications/sop-pupal-surveys/en/
19. R. A, A. V, Purty A, N. M. Assessment of environmental factors associated with dengue spread in an urban area of Puducherry. International Journal Of Community Medicine And Public Health. 2018;5(7):3020.
20. Niraj pandit et al. Awareness and practice about preventive method against mosquito bite in Gujarat. Healthline- J. 2010;1(1):2-5