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Original Research Article

Epidemiological and demographic characteristics of dengue and chikungunya infections over five years from 2014-2018, in Tamil Nadu, India

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ABSTRACT

Background: An epidemiological, demographic and seasonal trend analysis of dengue and chikungunya seroprevalence was performed in five districts of Tamil Nadu during 2014-2018.
Methods: Serum samples from the suspected patients were screened using IgM antibody ELISA.
Results: Dengue and chikungunya seropositivity ranged from 17.9-68.2% and 14.9-58.3%, respectively. Dengue cases were reported in all the years with a spike in 2017. Highest number of chikungunya cases was in 2018. Dengue cases peaked in the cooler months following monsoon while chikungunya data for seasonal trend analysis was not sufficient. Both viral infections were found common in the people >12 years, however, the difference of cases between males and females was not statistically significant.
Conclusions: The findings of this study indicate that both chikungunya and dengue are actively circulating in the state and the state health department needs to direct their efforts not only to control the spread but also on the future preparedness to prevent outbreaks.

Keywords: Dengue, Chikungunya, IgM, Tamil Nadu, Seroprevalence

INTRODUCTION

Spatio-temporal co-existence of dengue (DENV) and chikungunya virus (CHIKV) is very common. Both the DENV and CHIKV are carried by the same mosquito vectors and can thrive in the similar climatic and geographic conditions. Co-circulation of DENV and CHIKV is often reported in various endemic regions of India and the incidences of both the infections are increasing every year in India.[1-5] Tamil Nadu is one of the most affected states in the country where both DENV and CHIKV appears to be epidemic and endemic diseases, as regular cases are reported every year and several outbreaks have occurred in Tamil Nadu in the recent past.[4,6-11] The number of DENV and CHIKV cases is steadily increasing in several parts of the state in the last few years. Although the prevalence of Aedes aegypti and Ae. albopictus, the known vector species of the arboviruses and silent circulation of the viruses in the state are the major factors, the improvement in the surveillance system and diagnostic facilities along with better reporting and wide awareness among general public and healthcare workers are the contributing factors. An accurate diagnosis and reporting, leads to appropriate patient care and generation of accurate epidemiological data.

In this view, in the present study the dengue and chikungunya seroprevalence data from previous five years was analyzed. The serum samples from clinically suspected cases referred to virus research and diagnostic laboratory (VRDL) were tested for DENV and CHIKV detection. The results were analyzed to investigate trend of DENV and CHIKV prevalence over the five years period.

METHODS

This cross-sectional analysis of the data was carried out during 2014-2018 by Virus Research Diagnostic Laboratory (VRDL) at the Department of Microbiology, Madurai Medical College, Tamil Nadu India. The study area includes five districts in Tamil Nadu, including, Madurai, Dindigul, Virudanagar, Sivaganga and Ramnathpuram (Figure 1). Sample collection was done from the patients attending Outpatient department (OPD) of Government Rajaji Hospital, Madurai, Employee's State Insurance (ESI) and Hospital and Public Health Centres (PHC) of all the five districts. Patients with Age ≥ 5 years, having fever or history of fever for ≤72 hr; Suspected symptoms of possible dengue – i.e., undifferentiated fever and/or suspected CHIKV-like and DENV-like symptoms and no signs of severe disease were referred for diagnosis. Pregnant women, feeding mothers, patients with chronic and other serious diseases were excluded from the study. For diagnosis, 2 ml intravenous blood from each suspected patient was collected aseptically and transported to VRDL, Madurai in frozen conditions.

Before samples collection, written informed consent from each patient or their guardians was obtained. The study was approved by the Institutional Human Ethical Committee at Madurai Medical College, Madurai.

The details of the geographical position and the demographic details (as per the 2011 census) of the study area is furnished below; Madurai (9.9252° N, 78.1198° E): [Total population: 3,038,252; (male: 1,526,475 and female: 1,511,777)]; Dindigul (10.3673° N, 77.9803° E): [Total Population 2,159,775 (male: 1,080,938 and female: 1,078,837)]; Virudhunagar (9.5680° N, 77.9624° E): [Total Population 1,942,288 (male: 967,709 and female: 974,579)] and Sivaganga (9.9726° N, 78.5661° E): [Total Population 1,339,101 (male: 668,672 and female: 670,429)] Ramanathapuram (9.4071° N, 78.7023° E): [Total Population 1,353,445 (male: 682,658 and female: 670,787)].

Serum was separated aseptically from each blood sample by centrifugation, and was processed for dengue-specific IgM antibody Capture (MAC) supplied by the ICMR-National Institute of Virology (ICMR-NIV), Pune, Maharashtra, India. All the sera were subjected to ELISA for dengue detection as per the manufacturer's instructions as explained below briefly. For IgM ELISA, a total of 100 µL of negative and positive controls, calibrator and 100 µL diluted serum samples (1:100) were added to corresponding wells and incubated at 37°C for 60 min. The plate was washed 5 times and dried. Further, 100 µL of conjugate was then added, and plate incubated for 60 min at 37°C. After incubation, washing was done, and then 100 µL of substrate was added and incubated in dark for 30 min at 37°C. Finally, 100 µL of stop solution was added, and absorbance was read at 450 nm.

The data analysis was done using Statistical Package for Social Sciences (SPSS) version 16.0 (IBM Corp., Armonk, New York, USA). All the relevant variables were analyzed by descriptive statistics and statistical significance was assessed using $p<0.05$ as a threshold.

RESULTS

In this study, a total of 7128 and 234 serum samples collected from five districts over a period of five years were tested for DENV and CHIKV, respectively.

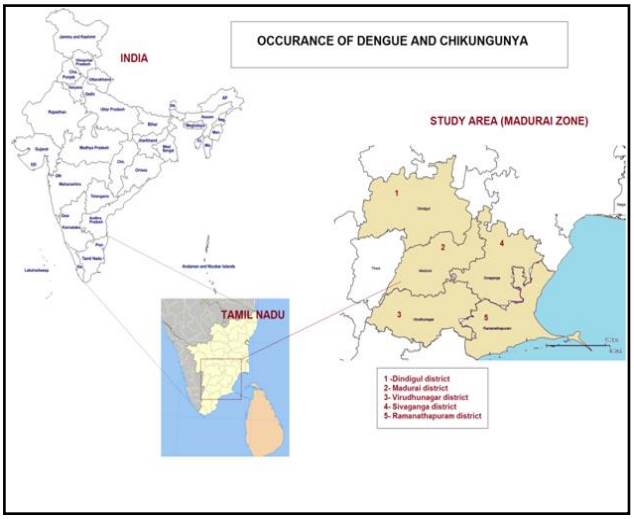

Figure 1: Map illustrating the study area in Tamil Nadu State.

Of the total, 3240 (45.5%) samples were DENV IgM positive and 120 (51.3%) were CHIKV positive. The maximum number of dengue cases was found in 2017, and the highest number of CHIKV positive cases were seen in 2018 (Figure 2). The overall rate of DENV seropositivity in five years ranged from 18% in 2015 (28/305) to 68% in 2017 (23/100) (Fig. 2A). CHIKV seropositivity among patients from the five districts in five years ranged from 15% in 2014 (7/47) to 58% in 2018 (70/120) (Fig. 2B). In 2017, Tamil Nadu witnessed several outbreaks and was the second largest dengue affected state in the country. On excluding 2017 dengue cases, the rate of DENV positivity varied from 0.18 to 0.30 without significant differences between the years except for years 2015 and 2018 ($p<0.005$). Similarly, excluding 2018 data, the difference in CHIKV seropositivity was not statistically significant ($p>0.05$) between years.

In terms of seasonal variations, dengue cases were seen sporadically distributed throughout the years. However, the number of cases started increasing in September till December or January and then started decreasing. The number of cases reached the peak in November/December in 2014 - 2017, and January in 2018 (Figure 3). The number of dengue cases started receding from February onwards. Maximum number of DENV cases occurred between September to February every year ranging from 70% in 2018 to 92% in 2016. However, in case of CHIKV, seropositive cases were observed in all the months of 2018 only. In all other years, very few CHIKV seropositive cases ranging from 1 to 15 were recorded throughout the year (data not shown).

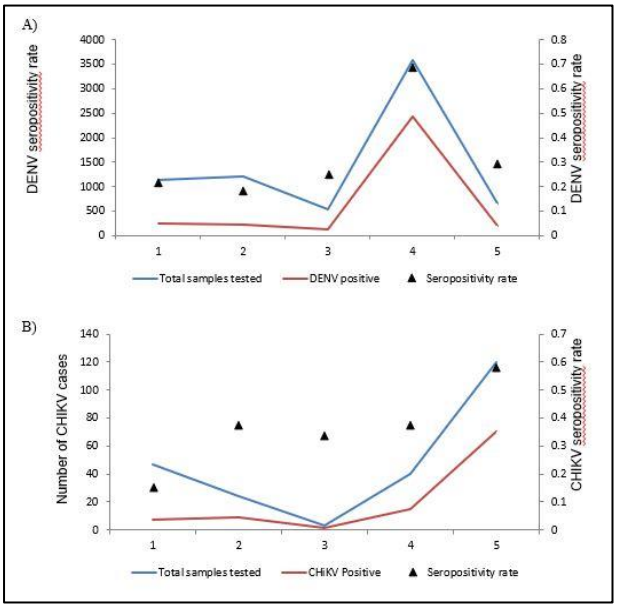

Figure 2: Trend of total number of samples tested, total positive cases and seropositivity rate of A) dengue and B) chikungunya over five years from 2014-2018 in five Sothern districts of Tamil Nadu, India.

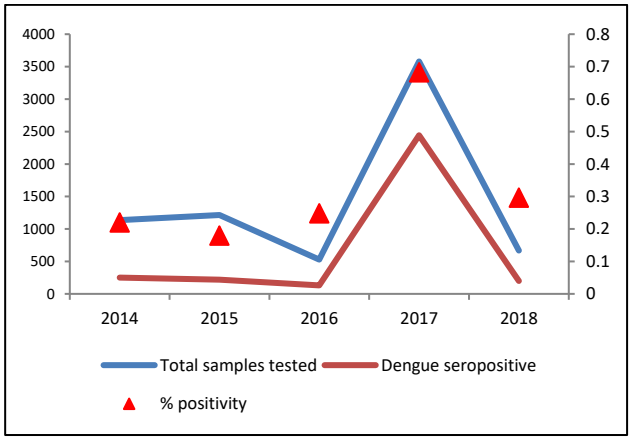

Figure 3: Monthly trend of dengue cases throughout the years from 2014-2018 in five southern districts of Tamil Nadu, India.

Gender-wise distribution of total positive cases and the positivity rate are shown in Figure 4. Of the 3240 DENV seropositive cases, 1603 patients were male, and 1637 patients were females. Irrespective of the number of positive cases, DENV seropositivity was high in males than that of females every year (Figure 4A). However, the difference was not statistically significant (chi square = 7.2535, p-value = 0.123). In case of CHIKV 49/120 (40.3%) were males and 53 out of 120 (44.2%) were females (Figure 4B). The rate of positivity was high in females in 2014 and 2018, and high in males in the years 2015-2017, however, the difference was not statistically significant across the years (chi square = 7.2535, p-value = 0.123) indicating that the dengue and CHIKV infections are not gender specific.

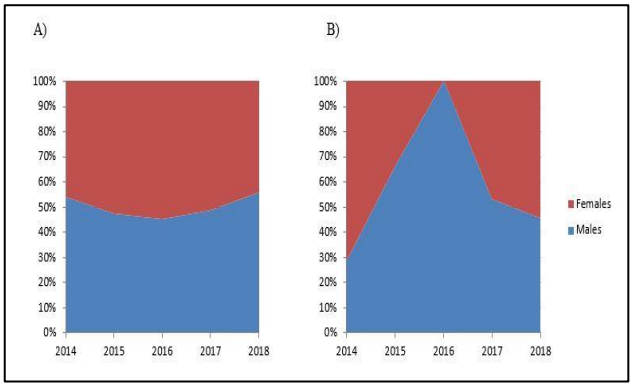

Figure 4: Gender-wise distribution of number of A) dengue seropositives and B) CHIKV seropositives over five years from 2014-2018.

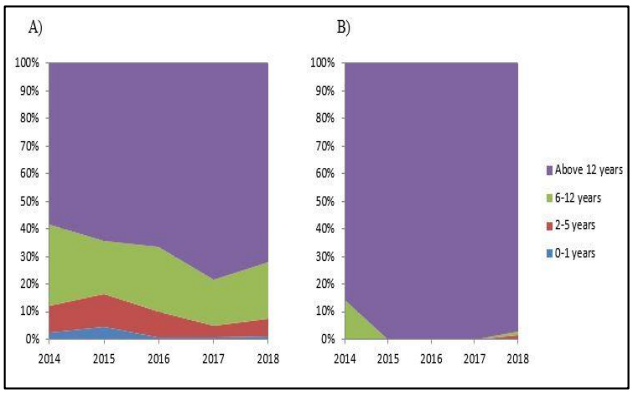

Figure 5: Age-wise trend of dengue A) number of seropositives and B) rate of seropositivity from 2014-2018.

Age-wise distribution of total positive cases and the positivity rates are shown in Figure 5. The total samples were categorized into four age groups; i) ≤ 1 year (infants), ii) 2–5 years (children), iii) 6–12 years (youth) and iv) > 12 years (adults). Most dengue cases occurred in individuals aged above 12 years in all the years (Figure 5A). However, positivity rate was the highest in infants (0-1 year) in 2014-2016 and in youth in 2017 and 2018 (data not shown). However, 97% of the total CHIKV positive

cases (99/102) were detected in adults (above 12 years), two cases in youth and only one in infants (Figure 5B).

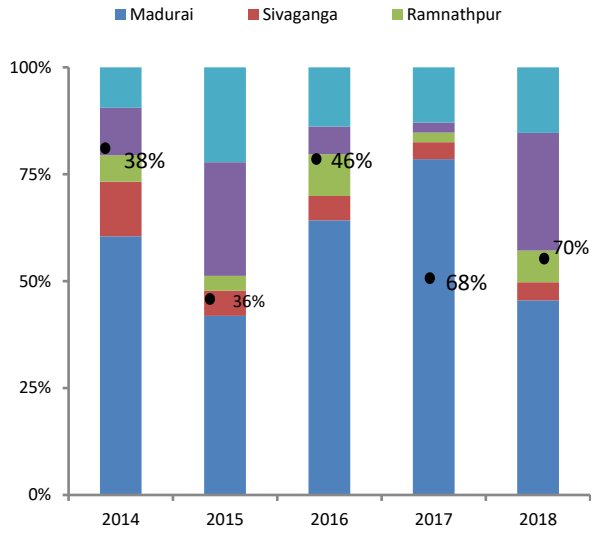

Figure 6: Trend of dengue infections in five districts of Tamil Nadu, from 2014-2018. Black dots with percentage values represent the maximum positivity rate each year in respective district.

Dengue seropositives were identified in all the five districts every year. Although numbers of referrals as well as the positive cases were highest in Madurai and the lowest in Ramnathpuram, the positivity rate of infection was the highest in Ramnathpuram in 2014, 2016 and 2018. In 2017, positivity rate was in range from 65-68% in all five districts except Virudanagar (18%) (Figure 6). While Virudhanagar showed highest positivity rate in 2015. In case of CHIKV, majority of the cases were identified from Madurai83.3% (85/102), followed by 7.8% (8/102) from Dindigul, 3.9% (4/102) from Virudhanagar, 2.9% (3/102) from Sivganga and 1.96% (2/102) from Ramnathpuram.

DISCUSSION

DENV and CHIKV are the importantvector-borne diseases in most of the parts of India. In Tamil Nadu, dengue has established firmly in almost all the districts. A large number of cases are reported every year in the state with a seasonal upsurge.[4,6–11] In Tamil Nadu, several outbreaks have also been reported in the recent past. The most recent dengue outbreak was observed in 2017 that caused 23294 cases and 65 deaths leading the state to the second highest in the country after West bengal.[9] Chikungunya outbreak was last reported in 2006 in several parts of South India and after that the cases are reported from the state every year.[12] In our study, the spike in CHIKV cases was observed in 2018 while the cases were very low ranging from 1 to 15 during 2014-2017. As per NVBDCP data, total 284 CHIKV cases were reported in Tamil Nadu that increased around three folds to 623 in 2019. In 2020 (till July),186 positive cases have already been reported. There are several reports from the state indicating silent circulation of CHIKV virus in the past and this sudden increase in cases might be due to the fading immunity to the virus or emergence of some strain in the affected populations.[4,13] It is also important to mention that improvement in accurate diagnosis, surveillance, better case reporting and awareness among general public and health workers might have played a significant role in the recent years.

In this study, we observed 45.5% dengue seropostivity in five years. When compared with the overall dengue seropositivity (30.58%) published by Ramalingam et al., from 20 districts in Tamil Nadu during 2011-2014 the seropositivity seem to be high in our study.[8] However, if we exclude 2017 outbreak data the seropositivity ranged from 17-29% which is lower than previous years (over all positivity 30.58%.[8] However, such comparisons can be misleading as the study procedures, study populations and many other factors are different between the studies. Comparing within our study, the number of cases showed a declining pattern from 250 in 2014 to 131 in 2016, 2443 in 2017 (outbreak) and 198 in 2018 (the year after outbreak). However, overall number of dengue cases (~22% seropositivity) is still very high considering the fact that majority of the dengue cases remain asymptomatic/mild and our data includes only the cases recorded by the Government hospitals. Even the sudden increase in CHIKV cases is alarming which warrants the need for strategizing effective methods to control and prevent the spread of these viral infections.

Among the five districts studied here, maximum cases of CHIKV and DENV were reported from Madurai. Madurai is the most populated and urbanized district among the five districts included in this study. Although DENV and CHIKV are no more urban disease and have been spread to rural areas too, the overcrowding, congested infrastructure, change in life styles and water scarcity, unhygienic surroundings and the better connectivity with the other endemic regions make urban areas more vulnerable for mosquito breeding and thus the hubs for diseases/infections transmitted by them.[11,14,15] It is also important to note that this study included two major Government hospitals of Madurai (corporation area) which might create biasness in the number of samples.

The seasonal trend analysis of the seropositive cases showed upsurge in the dengue cases post-monsoon (October – December) which is associated with the breeding of mosquitoes in the stagnated rainwater. The overall dengue seropositivity was high in the month of November (59.2%), followed by October (57.8%) and December (46.9%). This corroborates with the findings of several other studies from Tamil Nadu as well from other parts of India.[6,8,11,16,17] However, the cases were seen sporadically in all the months every year which is often associated with the water scarcity and the water storage practices of the people in the state. Water storage is the general practice in several parts of Tamil Nadu due to scarcity of water supply and the lower rainfall. Several

studies have reported that the water storage containers constituted the main breeding habitats for Aedes mosquitoes and the water storage practices are favorable to give rise to breeding of Aedes mosquitoes and are closely associated to the spread of dengue infection.[18-20] Thus proper community awareness can help in vector control and that can lead to break the infection cycle and curb the disease burden.

In our study, more number of both DENV and CHIKV cases were in the age group above 12 years; however the difference between males and females infections were not statistically significant. There are studies showing more cases in adults from other parts of the state and dengue cases more in children have also been reported from Tamil Nadu.[6,11] This is because; infection rate depends on the demography, socio-economic status, surroundings, occupation etc. This demographic trend can be region specific and thus periodic surveillance is important to revise and improve the area-specific disease/vector control efforts. Our study lacks the information about all these factors. However, the findings of this study provided several important observations such as both DENV and CHIKV are circulating these areas, incidence peak during and after monsoon, Madurai district is more affected and the people above 12 years are more affected and this information will be useful for planning more effective control programs in these areas.

CONCLUSION

This study is an another evidence of active circulation of both DENV and CHIKV in several parts of the Tamil Nadu. Even the increasing trend of CHIKV and the sudden outbreaks of dengue are alarming considering the complications associated with secondary dengue infections. Getting peak in cases very year at the same time (post-monsoon) is worrisome and needs up gradation/improvement in vector/disease control strategies. More efforts are needed in spreading community awareness and their involvement in vector control. Although, state health department has ramped up the facilities and the resources in the recent years, the findings of this study reinforce to direct the resources and efforts not only to control the spread but also to make strategies to handle the unexpected outbreaks in future.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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