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Epidemiological Scenario of Dengue Infection Over Two Years During 2021-2022, in Madurai Corporation

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ABSTRACT

Aim: To determine the incidence of Dengue in Madurai city during 2021 & 2022 by Dengue IgM ELISA and to analyse the epidemiological trend of Dengue infection including age, gender and seasonal variation.
Methods: Serum samples from the suspected patients were screened using IgM antibody ELISA.
Results: Maximum number of DENV cases occurred between October to March ranging from 43.3% in 2021 to 31.1% in 2022, with the peak in 2021 in February (19.7%) and in 2022 peak incidence was in January (18.1%). Dengue seropositivity was high in males than that of females. Though there is a slight difference, this is not statistically significant. Dengue positivity rate was the highest in Children less than 10 years and 11 – 20 years in 2021 and 11 – 20 & 21 – 30 years in 2022. In 2021 and 2022 more number of cases was found in Zone 4 followed by Zone 2. Zone 4 seems to be having more number of cases in both years.
Conclusion: This study is another evidence which revealed that the incidence of dengue cases is spatially distributed in entire Madurai Corporation area and also the active circulation of DENV in several parts of the Tamil Nadu. The state health department needs to direct their efforts not only to control the spread but also on the future preparedness to prevent outbreaks.

Key Words: Dengue, IgM ELISA, Epidemiological and Madurai Corporation

1. INTRODUCTION

Dengue is the most extensively spread mosquito-borne arboviral infection. It is caused by any of the four Dengue virus serotypes (DEN-1, DEN-2, DEN3, DEN-4) belonging to the genus Flavivirus, transmitted by the bite of female Aedes aegypti mosquito (CDCP 2013 & WHO,

2021). Dengue is found in tropical and sub-tropical climates worldwide, mostly in urban and semi-urban areas. Dengue virus is capable of infecting humans, and causing disease. A person can be infected with dengue virus multiple times in their life.

The infections may be asymptomatic or may lead to

a) Classical dengue fever, characterized by fever, headache, muscle and joint pain, rash, nausea and vomiting.
b) Dengue Hemorrhagic fever without shock.
c) Dengue Hemorrhagic fever with shock, a potentially lethal complication

Severe dengue is a leading cause of serious illness and death among children and adult. There is no specific treatment for dengue/ severe dengue, but early detection and access to proper medical care lowers fatality rates to below 1%.

The global incidence of dengue has grown dramatically in recent decades. From 2000 to 2019, the World Health Organization (WHO) documented a ten-fold surge in reported cases worldwide. Diseases such as dengue, malaria and yellow fever are some of the prominent vector-borne diseases accounting for one-sixth of the illnesses and disabilities in the world with more than half the population at risk (Campbell, *et. al*., 2015 & WHO, 2021). Dengue is a major public health problem in several countries and is endemic in several parts of India (Guzman and Kouri, 1996; Malavige, *et.al*., 2004; Arunachalam, *et.al*., 2008). In recent years it is appearing in the form of epidemics especially during rainy season. The earliest dengue epidemics occurred almost simultaneously in Asia, Africa, and North America in the 1780s.

After 2000, dengue and dengue hemorrhagic fever (DHF) have become diseases of serious concern due to thousands of reported cases and hundreds of deaths every year (Raheel, *et.al*., 2011). It is emerging and re-emerging in the tropics and currently poses the most significant arboviral threat to humans (Arunachalam, *et.al*., 2010). Prevention and control of Dengue depends on effective vector control measures.

Dengue virus transmission is ubiquitous with the highest risk in Asia (70%), Africa (16%) and South American countries (14%) [Bhatt S, *et.al*., 2013]. India alone contributes 14% of the global burden which is mainly due to densely populated areas that serve as ideal circumstances for the dengue borne mosquitoes to breed and spread disease [Mutheneni SR, *et.al*., 2017, Kakkar M. 2012 and Chakravarti A, *et.al*., 2011]. Aedes mosquito breeding is recorded in most of the districts of Tamil Nadu and it is noted in all the localities of Madurai (V. Saravanabavan., *et.al*., 2019).

The ‘‘domestic’’ form of A. aegypti is closely associated with human habitation, readily enters houses, feeds almost exclusively on human beings and is ubiquitous throughout the tropics. Urbanization (especially unplanned), is associated with dengue transmission through multiple social and environmental factors: Climate change, population density, human mobility, access to reliable water source, water storage practice etc.

The recent increase in number of dengue cases and geographical spread of the disease to new areas in Tamil Nadu warrants continuous monitoring of vector infections particularly due to dengue viruses.

Early recognition of dengue viral infection (DVI) by the routine serological test is exceptionally fundamental. IgM antibody is the first immunoglobulin isotype to appear. In a suspected case of dengue, the presence of anti-dengue IgM antibody suggests recent infection. Anti-dengue IgM antibody detection using enzyme-linked immunosorbent assay (ELISA) is one of the most important advances and has become an invaluable tool for routine dengue diagnosis (Kuno, *et.al*., 1998; Hati, 2006).

Knowledge of local prevalence of infections is critical in guiding clinical work up and treatment. As effective control and preventive programs for dengue infection are based upon improved surveillance data, the objective of this study was to analyse the

incidence of dengue virus infection in Madurai City. With this background, the present study was carried out by VRDL, Madurai to determine the incidence of dengue in Madurai city during 2021 & 2022 by Dengue IgM ELISA. This study analysed the epidemiological trend of Dengue infection including age, gender and seasonal variation. This will help to identify the risk zone of dengue disease in Madurai city which could help in rendering adequate control measures.

2. STUDY AREA

The study area is Madurai City. It is the headquarter of Madurai district. Madurai City is bounded on north by districts namely Dindigul and on the east by Sivagangai and on the west by Theni and south by Virudhunagar. The city has grown on both sides of river Vaigai and lies at a low altitude being only about 100 mts above the mean sea level. It is the fourth largest corporation by area and third largest city by population in Tamil Nadu. Madurai city has an area of 52sq.km with an urban area now extending over at much as 130 sq.km. The study area extends from 78º 00' to 78º 13' E longitude and 9º 48' to 10º 01' N latitude. The entire Madurai city located in the south-central part of Tamil Nadu was chosen as the study area. In 2011, the jurisdiction of the Madurai Corporation was expanded from 72 wards to 100 wards, dividing into four regions – Zone I, II, III and IV. The selection of the study area is to investigate the spatial distribution of Dengue in an urban and semi urban areas of Madurai city and its association with age, gender and seasonal variations. (Fig. 1).

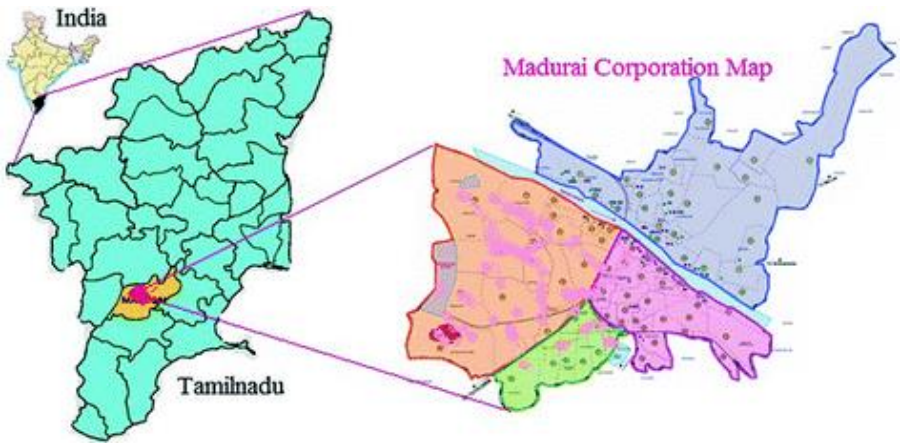


Fig: 1. Madurai Corporation Study Area Zone Wise Map

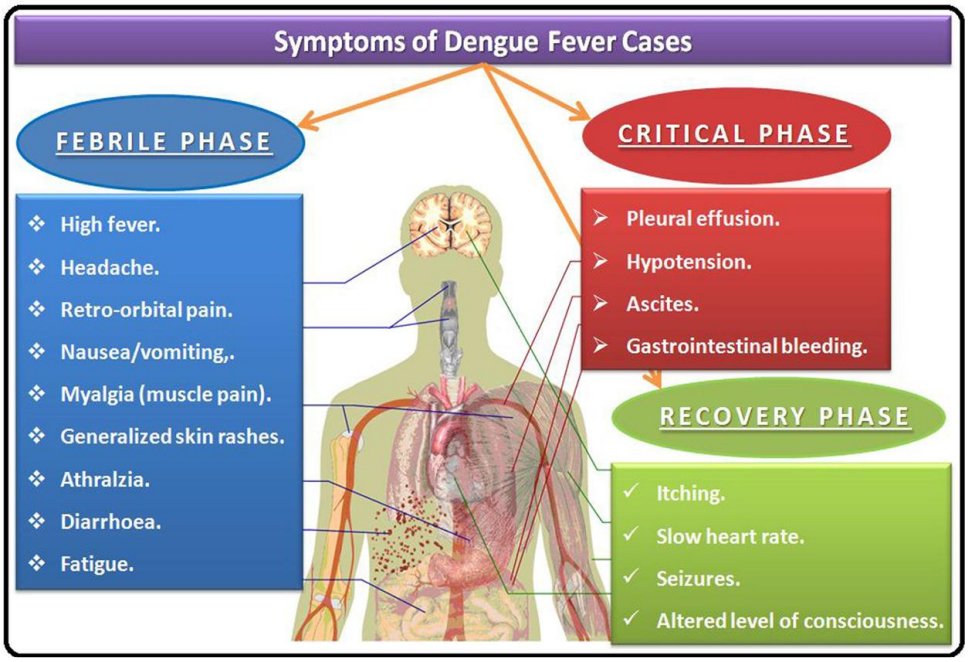
The maximum and minimum temperatures are 42˚ C and 21˚ C respectively in the city. The city experiences more rainfall during the northeastern monsoon season, which is in October and November and with occasional showers during the summer months under the influence of southwest monsoon. The average annual rainfall for 2022 is 881.5 mm.

3. MATERIALS AND METHODS

This prospective study was carried out during January 2021 to December 2022 by Virus Research Diagnostic Laboratory (VRDL) at the Department of Microbiology, Madurai Medical College, Tamil Nadu India. All the patients of both sexes aged 1 year to above 50 years admitted at GRH with proven case of Dengue fever using IgM ELISA Test were included in this study.

From January 2021 to December 2022, dengue suspected fever cases admitted in GRH were selected using passive case detection (PCD) from the study area of Madurai Corporation, in accordance with the observation of non-specific constitutional symptoms. The following criteria were considered for the selection of DF cases in three phases - febrile, critical

and recovery: (a) high fever, (b) headache, (c) retro-orbital pain, (d) nausea/vomiting, (e) myalgia (muscle pain), (f) generalized skin rashes, (g) arthralgia, (h) diarrhea, (i) fatigue, (j) pleural effusion, (k) hypotension, (l) ascites, (m) gastrointestinal bleeding in critical phase, (n) itching, (o) slow heart rate, (p) seizures and (q) altered level of consciousness.



In the case of DHF, the history of illness was revealed by the sudden rise of fever (38.3-39.4 ◦C), headache, retro-orbital pain, conjunctival congestion, and facial flushing with fever sustaining for 2-15 days. Additionally, some cases had a history of hemorrhagic manifestation, either with petechiae, gum bleeding, hematuria or melena. The following clinical specimen, i.e., Blood samples was collected from all of the febrile cases for the diagnosis of DENV infections.

This DENV diagnostic study was carried out during 2021 & 2022 by Virus Research Diagnostic Laboratory (VRDL) at the Institute of Microbiology, Madurai Medical College, Tamil Nadu India. Sample collection was done from the dengue suspected fever patients coming from nearby districts and got admitted in various wards of Government Rajaji Hospital, Madurai. 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. For diagnosis, 2 ml intravenous blood from each suspected patient was collected aseptically and transported to VRDL, Madurai in good conditions.

Blood samples were centrifuged; serum separated and then processed for dengue-specific IgM antibody Capture ELISA (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 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.

4. RESULTS

In this study a total of 3775 serum samples over a period of two years were tested for Dengue Virus positivity by IgM ELISA respectively. In 2021, out of 1780 suspected cases of dengue, 43.3% (771 Cases) were positive for dengue. Similarly in 2022, out of 1995 cases 31.1 % (620 Cases) were positive for dengue.

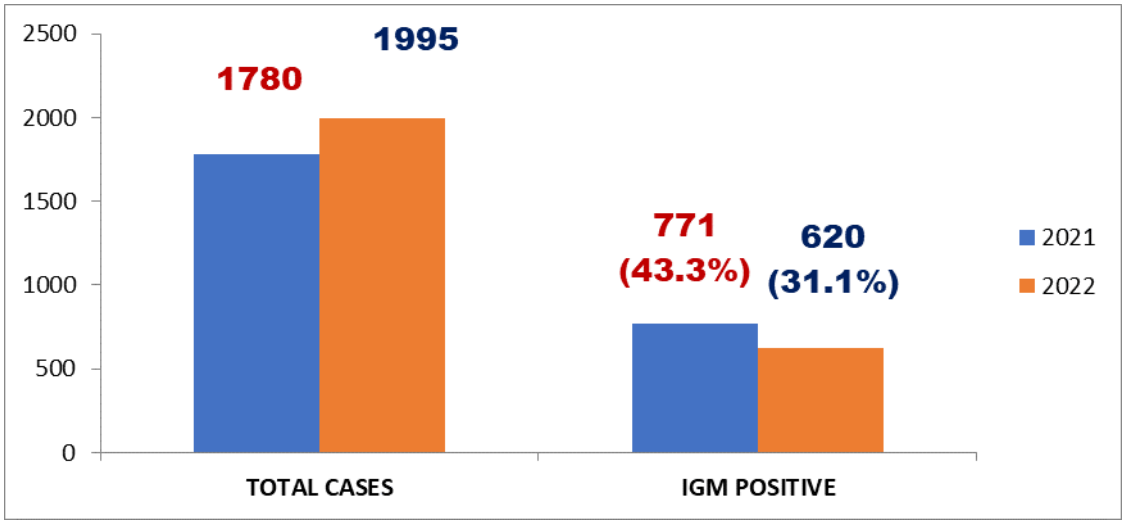


Fig. 2: YEARWISE DISTRIBUTION OF DENGUE POSITIVE CASES

In terms of seasonal variations, dengue cases were seen sporadically distributed throughout the years. However, the number of dengue cases started increasing during October to March in both 2021 & 2022 and then from April onwards started decreasing. The number of cases reached the peak in 2021 in February (19.7%) and in 2022 peak incidence was in January (18.1%). The incidence of dengue was comparatively lesser in months of April to September.

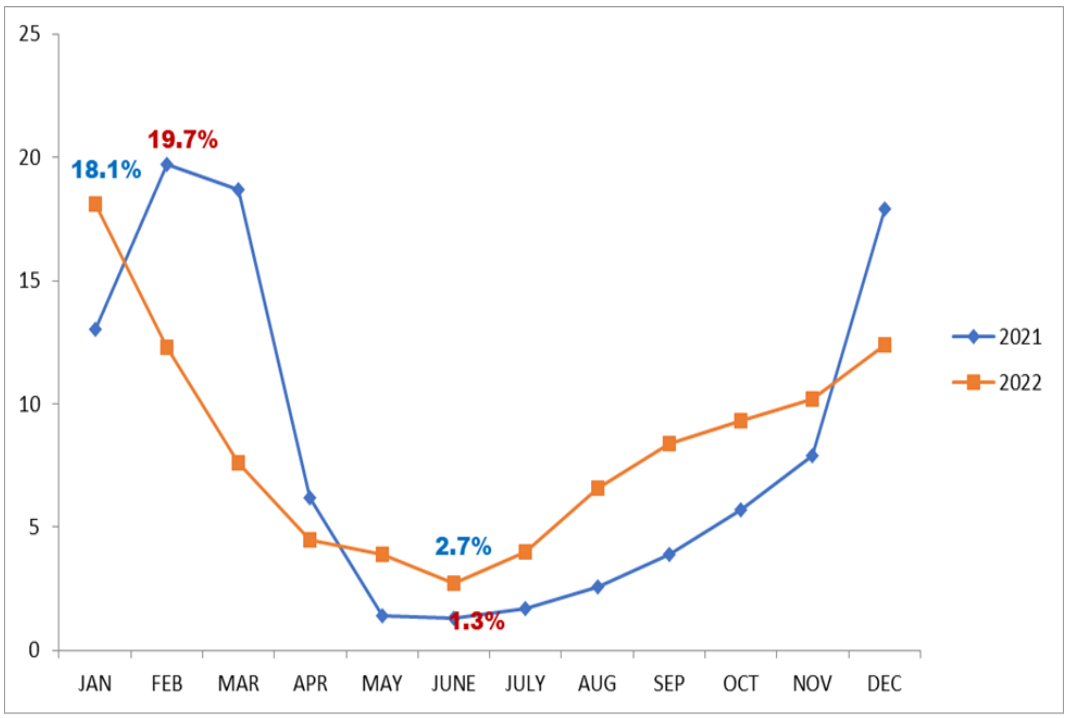


Fig. 3 MONTHWISE DISTRIBUTION OF DENGUE CASES

MONTHWISE DISTRIBUTION OF DENGUE CASES		
MONTH	**2021 POSITIVE**	**2022 POSITIVE**
JAN	13	18.1
FEB	19.7	12.3
MAR	18.7	7.6
APR	6.2	4.5
MAY	1.4	3.9
JUNE	1.3	2.7
JULY	1.7	4
AUG	2.6	6.6
SEP	3.9	8.4
OCT	5.7	9.3
NOV	7.9	10.2
DEC	17.9	12.4

Table 1: MONTHWISE DISTRIBUTION OF DENGUE CASES

Age-wise distribution of total positive cases and the positivity rates are shown in Table 2 & Figure 4. The total samples were categorized into six age groups; i) ≤ 10 year ii) 11 – 20 years iii) 21– 30 years iv) 31 – 40 years v) 41 – 50 years and vi) > 50 years. However, positivity rate was the highest in Children less than 10 years and 11 – 20 years in 2021 and 11 – 20 & 21 – 30 years in 2022. Were the most common age group affected by dengue. In 2022 more number of cases was in the age group of 11 - 20 year and 21 – 30 years. >50 years of age group was the least affected one.

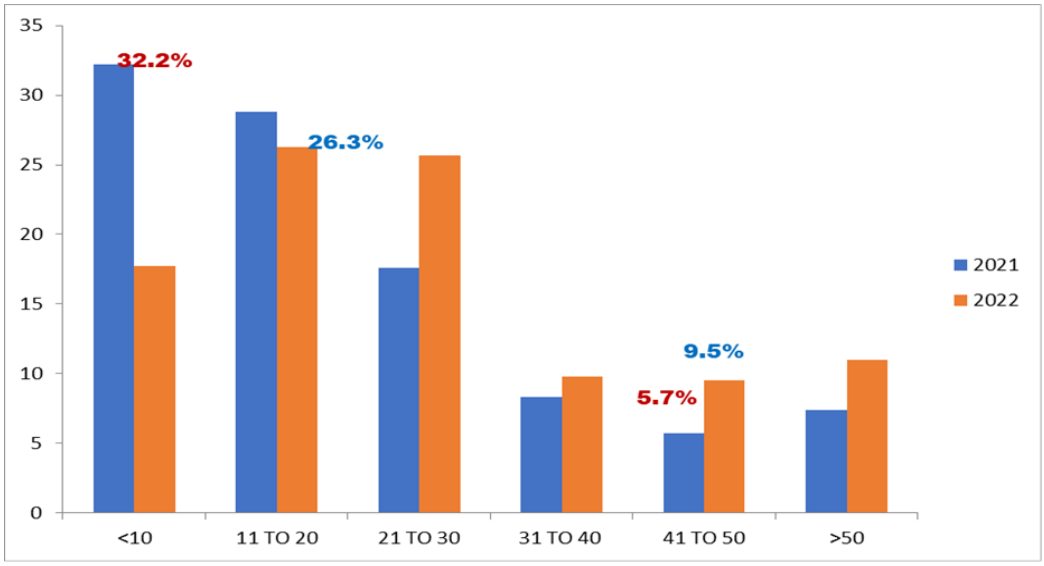


Fig. 4 AGEWISE DISTRIBUTION OF DENGUE POSITIVE CASES

AGEWISE DISTRIBUTION OF DENGUE POSITIVE CASES		
AGE GROUP	**2021 POSITIVE**	**2022 POSITIVE**
<10	32.2	17.7
11 TO 20	28.8	26.3
21 TO 30	17.6	25.7
31 TO 40	8.3	9.8
41 TO 50	5.7	9.5
>50	7.4	11

Table 2: AGEWISE DISTRIBUTION OF DENGUE POSITIVE CASES

Gender-wise distribution of total positive cases and the positivity rate are shown in Figure 5 & Table 3. Of the 771 Dengue seropositive cases in 2021, 401 were male and 370 were females. And in 2022 of the 620 Dengue seropositive cases, 312 were male and 308 were females. Irrespective of the number of positive cases, Dengue seropositivity was high in males than that of females. Though there is a slight difference, this is not statistically significant.

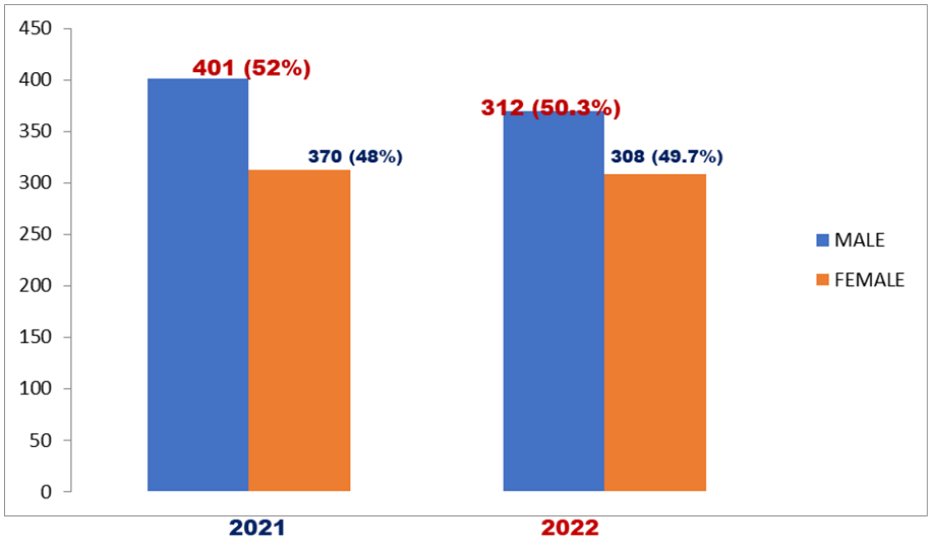


Fig. 5 GENDERWISE DISTRIBUTION OF DENGUE POSITIVE CASES

YEAR	MALE POSITIVE	FEMALE POSITIVE
2021	401	370
2022	312	308

Table 3: GENDERWISE DISTRIBUTION OF DENGUE POSITIVE CASES

The 100 wards in Madurai are divided into 4 zones by Corporation for administrative purposes. Zone 1 is the area in and around Vilangudi, Aarapalayam BB Kulam, Zone 2 covers Thiruppalai, Sellur K. Pudur etc., Zone 3 includes areas like Anuppanadi, Avaniyapuram, Villapuram etc, Zone 4 is the area in and around Subramaniyapuram, Jaihindpuram etc, the zone wise distribution of Dengue positive cases was also analyzed. In 2021 and 2022 more number of cases was found in Zone 4 followed by Zone 2. Zone 4 seems to be having more number of cases in both years.

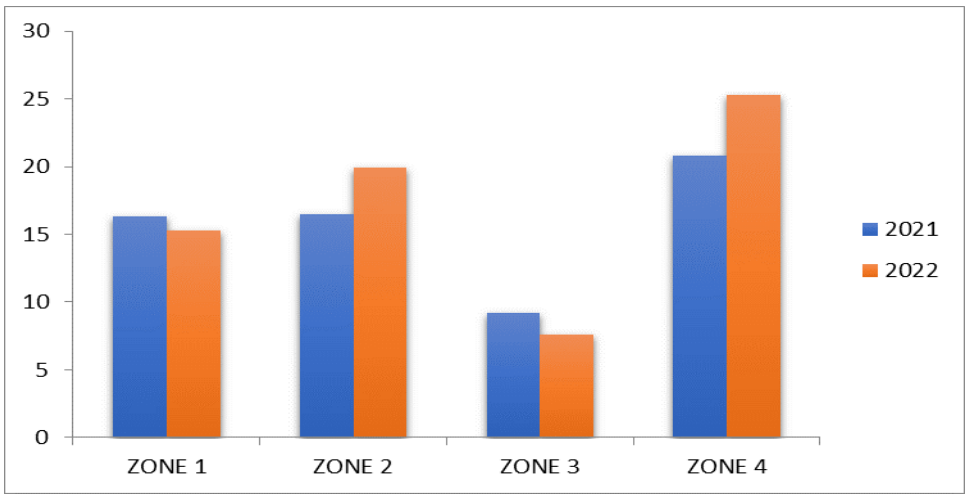


Fig. 6 ZONEWISE DISTRIBUTION OF DENGUE POSITIVE CASES

ZONE	2021 POSITIVE	2022 POSITIVE
ZONE 1	16.3	15.3
ZONE 2	16.5	19.9
ZONE 3	9.2	7.6
ZONE 4	20.8	25.3

Table 4: ZONEWISE DISTRIBUTION OF DENGUE POSITIVE CASES

5. DISCUSSION

In this study, a total of 3775 serum samples were collected from patients admitted in Govt Rajaji Hospital coming from various Zones of Madurai Corporation over a period of two years were tested for DENV. Dengue

is a very important emerging disease of the tropical and sub-tropical regions. The identification is by clinical features but they can present with varied manifestation. This study describes the clinical profile, laboratory features and outcome of DF/DHF/DSS in adult patients. During 2021 and 2022, a total of 3775 cases of DF were recorded. The maximum numbers of dengue cases were found in 2022, and the highest numbers of positive cases were seen in 2021. In 2021, out of 1780 suspected cases of dengue, 43.3% (771 Cases) were positive for dengue. Similarly in 2022, out of 1995 cases 31.1 % (620 Cases) were positive for dengue.

Sodani *et.al.,* denotes spread of awareness of dengue infection among health care workers and public has paved the way of increased serological tests leading to higher rate of detection of dengue cases over the past few years (Sodani, *et.al.,* 2015). The endemicity of dengue is spreading and has witnessed a 30-fold increase with rapid expansion to more than 100 countries in Africa, America, Eastern Mediterranean, South-East Asia and Western Pacific areas from urban to rural settings and worst affected regions are South-East Asia and Western pacific regions (Singla, *et.al.,* 2016; Kumar, *et.al.,* 2017). In this study 43.3% and 31.1% cases were dengue positive serologically which is lower than the findings of others (*Garg, et.al., 2011*; *Chitkara,* et.al., 2018). But the positivity rate of study is found to higher as compared to report of other studies (Sherchand, *et.al.,* 2001; Shah, *et. al.,* 2012; Bin Yunus, *et.al.,* 2002). Such variation in seropositive rate could be due to different geographical areas and climatic conditions (Kashinkunti & Shiddappa, 2013).

In India, the vulnerability of dengue has increased in recent years due to rapid urbanization, lifestyle changes and deficient water management including improper water storage practices in urban, peri-urban and rural areas, leading to proliferation of mosquito breeding sites (Kumar, *et.al.,* 2017). Determining the differences infection rate among male and female is important for public health control programmes. In this study higher incidence of dengue infection among male as compared to that of female was seen. Such higher incidence of dengue infection among male population than female population was similarly reported in other studies (Antony & Celine, 2014) and could be due to extensive exposure of males to dengue-carrying mosquitoes or differences in the healthcare-seeking behaviour of males and females (Anker & Arima, 2011; Arima, Chiew & Matsui, 2015).

The incidence of dengue fever was increasing during October to March in both 2021 & 2022. From April onwards incidence of cases started to decline. In 2021 the peak incidence was in February (19.7%) and 2022 peak incidence was in January (18.1%). The incidence of dengue was comparatively lesser in months April to September (Fig. 3). The incidence came down to period at the beginning of winter. According to previous studies, a steady increase in the number of dengue patients over the past few years was noted. This is due to the rapid urbanization with unplanned construction activities and poor sanitation facilities contributing fertile breeding grounds for mosquitoes. Due to an increase in the alertness among medical fraternity following the initial epidemic and availability of diagnostic tools in the hospital have contributed to the increased detection of cases. To identify the seasonal variation of the dengue infection, analysis of the data on monthly basis were done. A gradual increase in dengue positivity was noticed from September with a peak in October, in the year 2016 which is quite close to finding by Garg, *et.al,.* (2011).

Such pattern is an indication for weak relationship between monthly mean temperature and incidence of dengue as indicated by studies done by Hay, *et.al.,* (2002). As revealed by the study of Guha-Sapir & Schimmer (2005) the present study supports the oversimplification of the relationship between temperature, rainfall

and increasing vector-borne disease. However the indication of overall dengue infection in the three years of study seen mostly during rainy season of the state (June–October) indicates its correlation with monsoon season. Moreover anthropogenic climate change due to human activities such as extensive urbanization, explosive growth of population, deforestation/degradation of forests for industrialization, increasing emissions of fossil fuel, waste disposal etc. may have paved a way for increase of vector borne diseases such as dengue (Sethi & Bidyarani Sharma, 2017).

A gradual increase in cases was noticed during rainy season. Pre-monsoon increase in the number of cases was noted in the months of March and April due to the stagnation of water, after a few bouts of pre-monsoon rainfall which facilitate vector breeding. These findings highlight that preventive measures against dengue infection should be taken during water stagnation periods after the initial bouts of rainfall and at the end of monsoon.

The study revealed that majority of the cases was in the younger age group in both years. Children less than 10 years and 11-20 years were the most common age group affected by dengue. In 2022 more number of cases was in the age group of 11 - 20 year and 21 – 30 years. >50 years of age group was the least affected one. Dengue infection was found in all the age groups in our study but highest was seen in the age group of 21–30 yrs which is in accordance with the findings of the study done by Sodan, *et.al.*, (2015), Paul, *et.al.*, (2018) and Gupt, *et.al.*, (2016). Dengue infection is not age specific and not only children but adults are also equally under threat of dengue infection.

Gender-wise distribution of total positive cases and the positivity rate are shown in Figure 5. Dengue seropositivity was slightly higher in male when compared to female in both 2021 & 2022. Though there is a slight difference, this is not statistically significant.

In 2017, Tamil Nadu witnessed several outbreaks and was the second largest dengue affected state in the country. In terms of seasonal variations, dengue cases were seen sporadically distributed throughout the years. However, the number of cases started increasing in December to March and then started decreasing. The number of cases reached the peak in December in 2021 and 2022. The number of dengue cases started receding from February onwards. Maximum number of DENV cases occurred between October to March every year ranging from 43.3% in 2021 to 31.1% in 2022. This has conjointly been documented in our study. Most of the patients presented with dengue fever while dengue hemorrhagic fever and dengue shock syndrome were a minority group. Chandrakanta, *et.al*., reported that 60% cases of DHF were associated with DENV1. Concurrent infections may present the possibility of recombination between viruses leading to the emergence of more virulent strains, underscoring the need for continued surveillance and serotyping.

Zone-wise distribution of total positive cases and percentage are shown in Figure 6. The samples were collected from patients admitted in Govt Rajaji Hospital and who belong to any of the four zones (I, II, III and IV) from Madurai Corporation. Most dengue positive cases occurred in zone IV.

6. CONCLUSION

This study is evidence which revealed that the incidence of dengue cases is spatially distributed in entire Madurai Corporation area and also the active circulation of DENV in several parts of the Tamil Nadu. Even the increasing trend and the sudden outbreaks of dengue are alarming considering the complications associated with secondary dengue infections. Getting peak in cases every year at the same time (post-monsoon) is gradation/improvement worrisome in and needs vector/disease up 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.

Declaration by Authors

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Conflict of interest: None declared

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

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