

Seasonal Variation Influencing Dengue Transmission in Mumbai City: A Model for Outbreak Prediction



Medical Science

KEYWORDS : Dengue transmission, Seasonal variation, Mumbai city

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ABSTRACT

Objectives To study the seasonal variation in Dengue infection in Mumbai, India.

Methods 686 clinically suspected dengue patients, admitted in LTMMC & GH, Mumbai, a tertiary care hospital, were enrolled in the study and divided into two groups [Group A (<5 days fever) & Group B (>5 days fever)]. Serum samples of Group A, were tested for detection of dengue NS1 antigen and the same from Group B patients were tested for detection of dengue IgM antibody. *Results* In the study group, 28.13% patients were reactive for dengue infection. Maximum seropositivity (74.61%) was seen in between 15-45 years. Maximum reactivity (86.01%) was also seen in post-monsoon period.

Conclusion In this study, middle-aged male population represented the seropositive group of dengue infection. Maximum clinically suspected and dengue reactive patients were observed in post-monsoon period. Early identification and interventions against an impending outbreak are of critical value in prevention of the outbreak.

Introduction

Dengue is the most common arboviral infection, second most important mosquito borne infection in terms of morbidity and mortality. Humans are the main amplifying host of the virus. It is spread through the bite of infected female *Aedes aegypti* and *Aedes albopictus* mosquitoes.

The spectrum of diseases ranges from undifferentiated fever to more severe forms of Dengue haemorrhagic fever (DHF) or Dengue shock syndrome (DSS). DHF and DSS are the leading cause of hospitalization and death particularly among children. It affects up to 100 million people every year with 5,00,000 cases of DHF & DSS and about 30,000 deaths. Case fatality rates in endemic countries are 2.5%.⁽¹⁾

Dengue virus infection is a public health problem in Mumbai city, Maharashtra. They are caused by four dengue virus serotypes, namely DEN-1, DEN-2, DEN-3 and DEN-4 belonging to the genus *Flavivirus* and family *Flaviviridae* which are transmitted to humans by female *Aedes* mosquito (*Aedes aegypti* and *Aedes albopictus*).⁽²⁾ *Aedes* species are endophilic and a daytime biter; its biology, geographical area and transmissibility depend on climate, temperature, humidity and wind velocity. Increased precipitation levels provide greater habitat area for proliferation of the vector larvae thereby increasing vector population.⁽³⁾ The life cycle of *Aedes* spp. has two important phases: the aquatic (egg, larva and pupa stages) and the winged adult phase. The development and survival of the two phases and oviposition of the adult depend upon temperature and rainfall (humidity).⁽³⁾ Complex interactions of the ecology, environment, vector and virus serotypes are crucial factors driving dengue outbreaks.

Mumbai city constitutes a part of the western coast of Arabian Sea and has monsoon period from June to September, followed by post-monsoon period from October to January. Investigations of different parameters i.e. local weather conditions, migration of population for urbanization, largest congested slum area at Dharavi, plenty of under-construction sites in sub-urban Mumbai in comparison with different environmental and regional contexts can improve our understanding of the linkage between seasonal variation and dengue transmission, and provide strong scientific evidence for predicting future transmission patterns.

Therefore, there has been a need to develop early warning systems that can identify and quantify the risk of vector borne disease outbreaks such as Dengue, Malaria, Leptospirosis and more recently Chikungunya. An early epidemic prediction tool is critical for evaluating the risk of an outbreak that enables an objective evaluation of the risk and evidence based decision making about early interventions. This study attempts to assess the effect of seasonal variation on the incidence of dengue virus infection and the demographic profile affected in the Mumbai city, Maharashtra, western India.

Material & Methods

The study was performed in the Department of Microbiology of Lokmanya Tilak Municipal Medical College & General Hospital, Sion, Mumbai, Maharashtra in India, a tertiary care hospital with a bed strength of about 1500. The samples from clinically suspected dengue patients were collected over a period of one year (January, 2013 to December, 2013) and the parameters observed – dengue NS1 antigen, dengue IgM antibody, age and sex of the patient

and seasonal variation. The study was approved by the Institutional Ethics Committee, Lokmanya Tilak Municipal Medical College & General Hospital, Sion, Mumbai and also by Maharashtra University of Health Sciences, Maharashtra, India.

Six hundred eighty-six patients (N=686) who fulfilled the inclusion criteria mentioned above were selected for the study. A detailed history including the demographic profile, presenting complaints, past history and risk factors were elicited for each patient and duly recorded in the case record form. Consent was taken from each patient for participation in the study after explaining the protocol to the patient in the language that the patient best understood.

5 ml of blood was collected from clinically suspected dengue patients in a sterile vacutainer. Serum was separated as soon as possible by centrifugation at 2000 rpm for 20 minutes. The serum samples were preserved in sterile vials at -20°C and testing was carried out at the end of every month.

As per the duration of fever, samples were separated into two groups: **Group A: fever < 5 days (N=356)**, **Group B: fever > 5 days (N=330)**. Samples from Group A (fever < 5 days) were subjected for serological testing using commercially available Panbio Dengue Early Elisa kit for detection of dengue NS1 antigen and samples from Group B (fever > 5 days) were subjected for serological testing using Panbio Dengue IgM Capture Elisa kit for detection of dengue IgM antibody following the kit literature instructions.

Data were entered into Microsoft Excel Worksheet. Statistical analysis was performed using IBM Statistical Package for the Social Sciences version 20 (SPSS v20, IBM). Categorical variables between two groups were compared using Chi-square test and Fisher's exact test. A p value of <0.05 was considered significant.

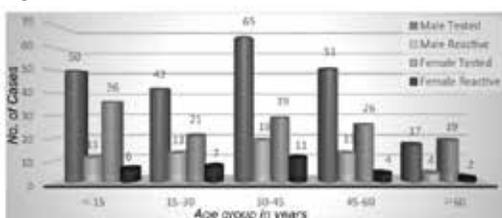
Results

In group A, amongst 356 patients, 90 (25.28%) were found to be reactive for dengue NS1 antigen. Maximum 50 (55.56%) patients belonged to the age group of 15-45 years with mean age 32.21 years. Male to female ratio among dengue NS1 reactive patients was 2:1.

TABLE 1: Dengue NS1 antigen reactivity among Study Group A (N=356)

Age Group (Years)	Male		Female		Total	
	Tested	Reactive	Tested	Reactive	Tested	Reactive (%)
≤15	50	11	36	6	86	17 (19.77)
15-30	42	13	21	7	63	20 (31.75)
30-45	65	19	29	11	94	30 (31.91)
45-60	51	13	26	4	77	17 (22.08)
≥60	17	4	19	2	36	6 (16.67)
Total	225	60	131	30	356	90 (25.28)

Figure 1



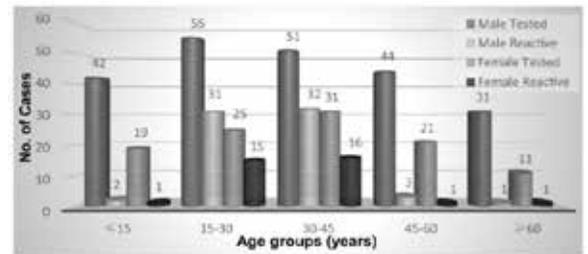
Among 330 patients of Group B, 103 (31.21%) were found to be reactive for dengue IgM antibody. 94 (91.26%) were

reactive from 15-45 years of age group with mean age 33.93 years. Male to female ratio among dengue IgM antibody reactive patients was 2.03:1.

Age group (years)	Male		Female		Total	
	Tested	Reactive	Tested	Reactive	Tested	Reactive (%)
≤15	42	2	19	1	61	3 (4.92)
15-30	55	31	25	15	80	46 (57.50)
30-45	51	32	31	16	82	48 (58.54)
45-60	44	03	21	01	65	4 (6.15)
≥60	31	01	11	01	42	2 (4.76)
Total	223	69	107	34	330	103 (31.21)

TABLE 2: Dengue IgM antibody reactivity among Study Group B (N=330)

Figure 2



Months	Dengue IgM ELISA		Dengue NS1 ELISA		Total		Reactive (%)
	Tested	Reactive	Tested	Reactive	Tested	Reactive	
January	15	2	8	2	23	4	2.07
February	6	2	1	1	7	3	1.55
March	2	0	0	0	2	0	-
April	1	0	0	0	1	0	-
May	0	0	0	0	0	0	-
June	0	0	0	0	0	0	-
July	3	1	3	1	6	2	1.04
August	17	4	24	4	41	8	4.15
September	21	5	25	5	46	10	5.18
October	68	28	70	24	138	52	26.94
November	132	38	156	33	288	71	36.79
December	65	23	69	20	134	43	22.28
Total	330	103	356	90	686	193	-

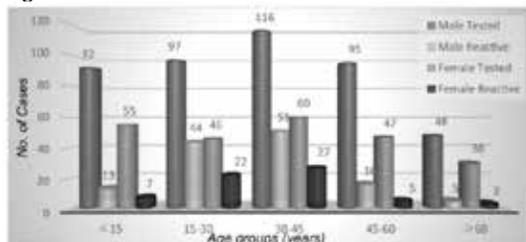
Out of total patients (n=686), 28.13% (193/686) were reactive for dengue infection either by dengue NS1 antigen or dengue IgM antibody. 144 (74.61%) were reactive from 15-45 years of age group followed by 21 (14.79%), 20 (13.61%) and 8 (10.26%) were reactive from 45-60, ≤15 and ≥60 years of age group respectively.

TABLE 3: Dengue Seropositivity in Study Group (N=686)

Age group (years)	Male		Female		Total	
	Tested	Reactive	Tested	Reactive	Tested	Reactive (%)
≤15	92	13	55	7	147	20 (13.61)

15-30	97	44	46	22	143	66 (46.15)
30-45	116	51	60	27	176	78 (44.32)
45-60	95	16	47	5	142	21 (14.79)
≥60	48	5	30	3	78	8 (10.26)
Total	448	129	238	64	686	193 (28.13)

Figure 3

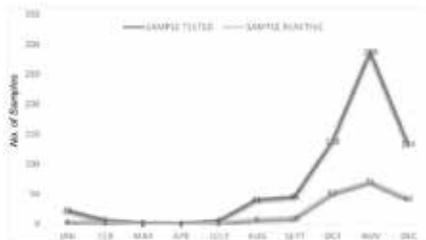


Regarding seasonal variation, maximum number of samples from clinically suspected patients of dengue were collected in November [288 (41.98%)], followed by in October [138 (20.12%)] and December [134 (19.53%)]. Maximum seropositivity was seen in November [71 (36.79%)], followed by October [52 (26.94%)] and December [43 (22.28%)] (post-monsoon period). No clinically suspected dengue patient was seen in the

TABLE 4: Seasonal Variation of Dengue infection among Seropositive Patients (N=193)

month of May and June. No dengue seropositivity was found in the month of March, April, May and June.

Figure 4



Discussion

Dengue virus infection has emerged as the most important and widely spread arboviral disease in the world. In the last 50 years, incidence has increased 30-fold with increasing geographic expansion to new countries and in the present decade, from urban to rural settings. It is endemic in most of the tropical and subtropical countries.⁽⁴⁾ The south-east Asian regions have recorded increasing incidence of dengue and have contributed to the major portion of global disease burden (nearly 75%). Dengue haemorrhagic fever (DHF) and Dengue shock syndrome (DSS) are endemic to these regions and pose a severe threat to global health. The first epidemic of clinical dengue-like illness was recorded in Madras (now Chennai) in 1780 and the first virologically proved epidemic of Dengue fever in India occurred in Calcutta and eastern coast of India in 1963-64.⁽⁶⁾ The first major wide spread epidemics of DHF and DSS occurred in India in 1996 involving areas around Delhi and Lucknow and then it spread to all over the country.⁽⁵⁾ Today Dengue virus and all its clinical forms are documented in almost all parts of India. The risk of transmission varies in space and time and the dynamics of the disease is dependent on seasonal changes in weather and immunity. Transmission is

particularly sensitive to rainfall, temperature and humidity. Thus, dengue is a climate sensitive disease and in Asia, the epidemics have been associated with the monsoon season.⁽⁶⁾

There has been a need to develop early warning systems that can identify and quantify the risk of vector borne disease outbreaks such as dengue, malaria and more recently chikungunya. An early epidemic prediction tool is critical for evaluating the risk of an outbreak that enables an objective evaluation of the risk and evidence based decision making about interventions. Early identification and interventions against an impending epidemic are of critical value in prevention of the epidemic instead of management.

In this study, most of the clinically suspected dengue patients were seen in post-monsoon period (from October to January).^(7,8) 583 (84.99%) samples were tested in this period. Out of which, 288 (41.98%) tested in November, followed by 138 (20.12%) samples in October and 134 (19.53%) samples in December. [Table 3] In monsoon, 6 (0.87%) , 41 (5.98%) and 46 (6.71%) samples were tested in the month of July, August and September respectively. [Table 3] Out of 686 samples tested, 193 were reactive for Dengue virus infection. High seropositivity was observed in the post-monsoon period i.e. 88.08% (170/193). Maximum 71 (36.79%) samples were reactive in November, followed by 52 (26.94%), 43 (22.28%) and 4 (2.07%) were reactive in October, December and January respectively. These findings correlated with the findings of many studies conducted in India for the same parameters. Ukey *et al*⁽⁹⁾ in 2005 reported 36.59% dengue seropositivity in November, followed by 25% reactivity found in the month of October, while in 2006, maximum 40% dengue seropositivity was found in the month of November. Similarly a study conducted by Ratho *et al*⁽¹⁰⁾ showed similar finding with maximum number of seropositive patients in the month of October and November (post-monsoon period). Tahir *et al*⁽¹¹⁾ in their study, showed that all dengue reactive cases were seen from the month of September to December with a peak in November, indicating a seasonal trend of the outbreak in the post-monsoon period.

Our present study established high prevalence of dengue infection in the post-monsoon period. Presence of stagnant water after rainfall favours mosquito breeding which leads to an increased occurrence of dengue. Moreover, in large urban settings with peripherally growing cities where urbanisation is an on-going process, possible larval habitat of *Aedes* mosquitoes is concrete drainage system and incomplete construction sites with multiple temporary, residential accommodations. The growing urban population and the increasing population mobility with rapid development of transportation may contribute to the increasing seropositivity of Dengue virus infection in post-monsoon period.

The correlation between occurrence of dengue and post-monsoon season is clearly evident in the present study. These finding indicates that extra preventive measures against dengue infection should come into full swing during water stagnation periods at the end of monsoon. In this geographical area, rainfall usually starts from June (Monsoon period: June to September). However, during our study period, rainfall started late from mid-July. This explains the paucity of clinically suspected patients and dengue reactivity in the monsoon period. There was gradual rise of clinically suspected patients as well as number of dengue seropositivity from mid-July to August and September.⁽⁷⁾ In pre-monsoon period, (from February to May)^(7,8) a total of 10 samples were tested, out of which, 3 samples were reactive for dengue virus infection. All 3 reactive

were reported in the month of February. Siqueira *et al*⁽¹²⁾ in their study, suggested the low seropositivity may be due to low viral activity in pre-monsoon period (dry period).

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