

## *Chapter-1*

**CASE STUDY ON SELECTED *FLAVIVIRUSES*  
(DENGUE, WEST NILE AND YELLOW FEVER  
VIRUSES) IN CHENNAI, TAMILNADU**

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## MOSQUITO SPREADING VIRAL DISEASES

Mosquitoes are found throughout the world. There are about 3,500 species, of which nearly three-quarters are native to the humid tropics and subtropics (Bagny, *et al.*, 2009). India is endemic for three important mosquito-borne viral diseases, viz. Dengue Virus, West Nile Virus and Yellow Fever Viruses. Since these diseases are spread all parts of India. The Dengue and Yellow Fever Viruses transmitted by *Aedes mosquitoes*, West Nile Virus transmitted by *Culex* mosquitoes is endemic in India. These three infections maintained specific distribution patterns. While Dengue, DHF was confined to urban areas. However, over the past two decades, Dengue, Dengue Hemorrhagic Fever (DHF) penetrated urban and rural areas along with piped water supply, West Nile have hit the peri urban areas of urban centres, thus increasing the chances of commitment infections in the human population.

### SPREADING OF FLAVIVIRAL DISEASES (DENGUE, WEST NILE AND YELLOW FEVER VIRUSES)

Dengue (DEN), West Nile (WN) and Yellow Fever (YF) viruses are globally important, re emerging mosquito-borne *flaviviruses* that cause widespread human disease and mortality (Mackenzie *et al.*, 2004). West Nile Virus (WNV), the four Dengue Viruses (DENV1-4) and Yellow Fever Virus (YFV) are *flaviviruses* belonging to the *Flaviviridae* family (Lindenbach, *et al.*, 2007). Many mosquito-borne *flaviviruses* cause a wide range of severe diseases. The mosquito-borne cluster of *flaviviruses* cause either systemic manifestations (e.g., fever and hemorrhage) or primarily neurological damage (e.g., encephalitis). Yellow Fever Virus (YFV) and Dengue Viruses cause systemic illnesses whose outcomes range from mild to death, and manifestations include high fever, severe headache, retro-orbital pain, and rash (Gould *et al.*, 2008). Dengue Fever (DF) can progress to Dengue Hemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS) (Simmons, *et al.*, 2012). The global health impact of the four DENV viruses is staggering: Dengue viruses threaten half of the world's population, and result in ~400 million infections and 15,000–30,000 deaths per year (Bhatt, *et al.*, 2013). Among the neurotropic viruses, WNV infections have systemic and also neurological manifestations, as many as 10% of WNV infected patients with neurological symptoms succumb to the disease (Gould *et al.*, 2008).

All *flaviviruses* have a ~11 kb positive strand RNA genome and mRNA, which is translated into a single polyprotein that is cleaved into three structural and seven non-structural (NS) proteins necessary for viral propagation (Lindenbach, et al., 2007). The flavivirus lifecycle involves complex interactions with many of the host cell cytoplasmic and, very likely, nuclear structures and components. WNV and DENV1-4 enters cells via interactions with one or more receptors and co-receptors at the plasma membrane, delivers its genome to the cytoplasm, and sets up translation-replication-assembly factories in membranous structures associated with the endoplasmic reticulum. The assembled progeny virions will eventually leave the cells through secretory pathways, and initiate subsequent infections.

Given their genome's limited coding capacity and their lifecycle's complexity, it is not surprising that flaviviruses require scores of host factors (Fernandez-Garcia et al., 2009, Pastorino et al., 2010). These host factors are gene products (RNA or protein) that critically impact viral replication either positively (dependency or proviral factor) or negatively (restriction or antiviral factor). The identification of these hosts' factors and the characterization of their interactions with viral proteins and RNAs are critical for the understanding of Flaviviral replication, and should significantly inform our understanding of disease progression and pathogenesis. Moreover, each of these host factors is a candidate for therapeutic intervention.

In this chapter we will provide a review on the current mosquito borne viral diseases spreading in Chennai.

## DENGUE

Dengue is an acute viral infection with potential fatal complications. Dengue Fever was first referred as "water poison" associated with flying insects in a Chinese medical encyclopedia in 992 from the Jin Dynasty (265-420 AD). The word "dengue" is derived from the Swahili phrase *Ka-dinga pepo*, meaning "cramp-like seizure". The first clinically recognized dengue epidemics occurred almost simultaneously in Asia, Africa, and North America in the 1780s. The first clinical case report dates from 1789 of 1780 epidemic in Philadelphia is by Benjamin Rush, who coined the term "break bone fever" because of the

symptoms of myalgia and arthralgia (quoted from [www.globalmedicine.nl/index.php/dengue-fever](http://www.globalmedicine.nl/index.php/dengue-fever)). The term dengue fever came into general use only after 1828.

Dengue Fever is rearing its ugly head again in India with new cases of infections and even deaths being reported from different States. The world's fastest growing vector-borne disease, Dengue sees an estimated 50-100 million cases reported annually in over 100 endemic countries. Ever since its detection in the early 1950s, there has been a 30-fold increase in Dengue incidence. All most half of the world's population is currently considered at risk of contracting Dengue. The Southeast Asia region contributes to more than half of the global burden of the disease. About 52 percent of the world's population at risk resides in this region. Dengue is endemic in 10 of the 11 member states, and India, Indonesia, Myanmar, Sri Lanka and Thailand are among the 30 most endemic countries in the world. More than 4, 00, 000 cases of dengue were reported in this region in 2013 (THE HINDU, October 2014). The WHO 2009 classification divides dengue fever into two groups: uncomplicated and severe, though the 1997 WHO classification is still widely used. The 1997 classification divided dengue into undifferentiated fever, Dengue Fever (DF), and Dengue Haemorrhagic Fever (DHF). Four main characteristic manifestations of dengue illness are (i) continuous high fever lasting 2-7 days; (ii) haemorrhagic tendency as shown by a positive tourniquet test, petechiae or epistaxis; (iii) thrombocytopenia (platelet count  $<100 \times 10^9/l$ ); and (iv) evidence of plasma leakage manifested by haemoconcentration (an increase in haematocrit 20% above average for age, sex and population), pleural effusion and ascites, etc

### **DENGUE IN TAMILNADU**

Dengue infection has been known to be endemic in India for over two centuries, as a benign and self-limiting disease. Dengue has been rampant in parts of Tamil Nadu in the past two decades. 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 (Sarkar et al., 1964). DENV-1 was isolated in 1956 at Vellore, Tamilnadu (Patil et al., 2011). The prevalence of dengue vector and silent circulation of dengue viruses have been detected in rural and urban areas of Tamil Nadu, which is ever increasing (Tewari, et al., 2004). The seasonality of transmission of dengue showed increased activity during

monsoon and post monsoon. These findings indicate that during epidemic as well as non-epidemic years, dengue infections are mostly seen in monsoon and post-monsoon season.

### **INCREASE IN NUMBER OF CASES IN CHENNAI**

However, an area of concern is that the number of cases has been increasing year after year. To understand it, we need to comprehend and keep pace with the changing epidemiology of dengue, especially the multiple ecological factors that influence its spread. Being a vector-borne disease, ever-increasing numbers and varieties of mosquito-breeding habitats are being created with rapid and poorly planned urbanization, globalization, consumerism, poor solid waste and water management, and increasing population movement without adequate measures to prevent vector breeding. Climate change also influencing ecology that encourages vector breeding

The outbreak of Dengue, like other vector - borne diseases is determined by socio-economic factors that include reduced access to health services, housing, sanitation, water supplies and poverty. Efficient, effective and sustainable prevention and control of vector borne diseases requires not only the biomedical tools, but interventions to address these factors as well.

The accumulation of modern non-bio degradable products such as automobile tyres, plastic containers and tin products provides a conducive environment for prolific breeding of *Aedes aegypti* and *Aedes albopictus* vectors of Dengue. Hence, effective and sustainable prevention and control of Dengue requires interventions that address these factors in an integrated and multi-sectoral manner. The theme of World Health Day focused on vector borne- diseases to acknowledge their public health importance, raise global awareness and increase commitment on controlling them.

### **WEST NILE VIRUS**

WNV is recognized as the most widespread virus among *flaviviruses*. It was first isolated during 1937 in the West Nile district of Uganda from a patient suffering from mild illness. In India, this virus has been isolated from human beings (George, et al.,1984, Paul et al.,1970., Kedamath., 1984), domestic pigs and mosquitoes (Rodrigues et al.,1980., Rodrigues et al.,1969). The WNV isolate (724268) was recovered from a pool of 100 Cx.

*vishnui* mosquitoes, collected resting outdoors in bushes at Mudikonda village, Khammam taluk, Khammam district, Andhra Pradesh. In another study, two strains of WNV have been isolated from two pools (pool size 48 and 50 females respectively) of *Cx. Fatigans* (*Cx. quinquefasciatus*) at Manjri, Pune. Of 5553 *Cx. vishnui* mosquito pools (containing 738, 291 mosquitoes), Dandawate, *et al.* (Rodrigues *et al.*, 1969) isolated five strains of WNV from five pools with a pool sizes ranging from 74 to 150 mosquitoes collected from North Arcot districts of Tamil Nadu and Chittoor district of Andhra Pradesh (Dandawate, *et al.*, 1969).

### WEST NILE VIRUS IN TAMIL NADU

West Nile virus (WNV) is an arthropod borne virus of public health importance. WNV is a member of the genus flavivirus and belongs to the family *flaviviridae*. WNV infection is a self-limited, non-fatal mild febrile illness but occasionally reported to cause Encephalitis (Komar *et al.*, 2000). It causes mortality in horses (Murgue *et al.*, 2001), domestic and wild birds (Komar *et al.*, 2000). The emergence of WNV in America (Asnis *et al.*, 2000) and its impact on the health of humans, horses and birds, have caused global concern about this virus. In India, this virus is known to be active in mosquitoes, birds and pigs. It has also been associated with human encephalitis cases (George *et al.*, 1984). Therefore, it is felt necessary to review the present status of WNV in context with Indian scenario.

In India, presence of West Nile antibodies in humans was first reported from Bombay (now Mumbai) by Banker in 1952 (Smithburn *et al.*, 1954) confirmed the report by detecting the WNV neutralizing antibodies. During a post sero-epidemiological study, (Risbud *et al.* 1991), detected WNV neutralizing antibodies among humans at South Arcot district of Tamil Nadu. WNV has been isolated from sporadic cases of encephalitis and mosquitoes (Work, 1971). Postulated a hypothesis of a zoogeographical interface of Japanese encephalitis and West Nile Virus. The hypothesis proposed the intermingling distribution of and WNV at the south Indian peninsular region. The relative prevalence of WNV needs to be studied in India. From the available data, it is evident that different viruses may predominate in different years since in North Arcot District of Tamil Nadu (Risbud, *et al.*, 1991) observed a higher prevalence of neutralizing antibodies to WNV during a post encephalitis outbreak survey in 1982, whereas in the same area, during 1989 and 1990 (Gajanana, *et al.*, 1990) found a low prevalence of WNV.

### Natural cycle

WNV is reported to be maintained in the nature in a cycle involving certain birds and mosquitoes. Mosquitoes are principle vectors of WNV. Outbreaks of WNV infection coincided with the increased population of the *Culex* mosquitoes during summer in temperate regions and during rainy seasons in tropics (Baqar et al., 1993).

### YELLOW FEVER

*Ae. aegypti* is the primary vector for transmission of dengue in Asia which is considered as a possible vector for Yellow Fever (YF) if it ever occurred in Asia. Yellow fever is a *flavivirus* infection that is transmitted primarily by mosquitoes of the species *Aedes spp.* and *Haemagogus spp.*, with humans and non-human primates being the main vertebrate hosts. It is endemic in tropical areas of Africa and Central and South America. The clinical course of infection in humans shows a wide spectrum of severity including asymptomatic infection, mild illness with flu-like symptoms, and severe disease including fever with jaundice or haemorrhage and death. Several different transmission cycles have been defined, depending on which host and vector species are involved in transmission: in the sylvatic cycle, tree-dwelling mosquitoes of *Aedes spp.* (Africa) or *Haemagogus spp.* (Americas) transmit the virus to non-human primates. In this cycle, spill over infection of humans occurs when they encroach on this jungle habitat conversely, in the urban transmission cycle, humans are the main hosts with transmission occurring via domestic mosquito species. The typical urban vector is *Aedes aegypti*, which also serves as the main vector for dengue virus transmission. If Yellow Fever is introduced into urban areas, large explosive outbreaks can occur, which can be difficult to control. In Africa, there is also an intermediate transmission cycle that occurs in rural areas typically at the edges of forests with humans as well as non-human primates affected, and transmission driven by domestic and semi-domestic mosquito species (Monath, 2001).

Yellow fever (YF) is a life-threatening mosquito-borne Flaviviral Hemorrhagic Fever (VHF) characterized by severe hepatitis, renal failure, hemorrhage, and rapid terminal events with shock and multi-organ failure (Monath, 2008). It is an acute viral hemorrhagic disease caused by RNA virus with positive sense of the Flaviviridae family. YF Virus is the prototype virus with a genome of 10,862 nucleotides with a 5' CAP structure and a non

polyadenylated 3' end encoding a polyprotein of 3,411 amino acids which is cleaved by proteolytic processing to give rise to 11 viral polypeptides. Nucleotide sequence analyses of flavivirus genomes have led to new insights into genome structure and replication (Galler, et al., 1998). Till now there are no specific antiviral agents for the treatment of Yellow Fever Virus (YFV), there are still approximately 30,000 deaths worldwide each year and cases have been increasing in the last 20 years (Bhattacharya, et al., 2008). The virus is endemic in Africa and South America, but cases of YFV have been reported in non-endemic areas also. YFV is related to hepatitis C, Dengue, West Nile and other viruses of human concern. Mosquito species of *Aedes* and *Haemogogus* species transmit YFV and serve as a reservoir for the virus; humans and monkeys are the primary hosts for viral infection. The disease may be limited to a mild febrile illness or may be more severe, including jaundice, renal failure, vascular instability and shock (Bhattacharya, et al., 2008). There is an approximately 50% case fatality rate in severe YFV cases (Tomori, 2004).

#### **GENERAL FEATURES OF CHENNAI**

Chennai is located at 13.04°N 80.17°E on the southeast coast of India and in the northeast corner of Tamil Nadu. It is located on a flat coastal plain known as the Eastern Coastal Plains. The city has an average elevation of 6 metres (20 ft), its highest point being 60 m (200 ft). Chennai features a tropical wet and dry climate. Chennai lies on the thermal equator and is also coastal, which prevents extreme variation in seasonal temperature. For most of the year, the weather is hot and humid. The Corporation maintains 75 dispensaries, 36 malaria clinics, 42 tuberculosis microscopic centres, and 1 centre each for communicable diseases, NGO-run malaria clinic, filaria clinic, and filaria lymphodema management clinic. The Corporation maintains three slaughterhouses in Perambur, Villivakkam, and Saidapet, where an average of 1,500 sheep and 150 cattle are slaughtered every day (Rajagopalan, P.K., 1987). As per 2012-2013 corporation budgets, 11 new dental clinics will be set up in addition to the existing ones to ensure that every zone has a clinic. A new hospital will be set up with a specialised leprosy centre and Mandambakkam to benefit the residents of South Chennai (Pratiksha Ramkumar 2012). In 2007, it was reported that mosquitoes were the biggest menace in the city (Mosquitoes, not water, Chennai's Problem No.1, 2007). In 2012,



the Corporation announced that it was planning to breed sterile male mosquitoes to bring down the population of female mosquitoes (Chennai Corporation's new plan 2012).

## **REASONS FOR SPREADING DISEASES**

### **URBAN AREA:**

Emergence and resurgence of mosquito-borne diseases such as, Dengue, West Nile, Yellow Fever and Filariasis both in tropical and subtropical regions are well known. Urban areas are generally highly polluted areas. The geo climatic conditions in India are conducive for the transmission of vector-borne diseases. The magnitude of the mosquito menace and prevalence of mosquito-borne diseases depend upon various factors such as developmental activities, human interference, climatic changes, availability of parasitic load in the community and socio-cultural practices (WHO ,1998, Panicker, et al.,1986).In the state urban areas, acute water shortage forces people to store water in vessels that help water stagnation in areas resulted in increase in the number of *Aedes aegypti* and *culex* mosquitoes spread diseases.

The presence of a particular mosquito species is dependent on the type of nearby wetland or habitat. Examples of different habitats that produce different mosquito species include permanent swamps, temporary woodland pools, river flood plains, cattail swamps or artificial containers. The last item can be almost any container which can hold stagnant water for at least a week in the summer, including roadside highway drains, old rimless tires, unused swimming pools, uncovered empty trash cans, and bird baths.

The species of mosquito found at any one time in an area is dependent on temperature and season; there are early spring, late spring, summer, and mid-summer species. Some mosquito species have several generations each summer, so their populations increase as the summer goes along. Most mosquito species are active primarily during dusk and dawn or during cloudy warm days. However, one local species is active all night and some species will bite during hot sunny days. Three of our local mosquito species will enter protected shelters such as houses, and it is usually one of these three species that annoy people while they are trying to sleep.

While some mosquitoes are indiscriminate about what they bite, most are selective. Some of our mosquito species feed primarily on humans and other mammals, while others mostly bite birds, and still others feed on amphibians (such as frogs) or reptiles (such as snakes). Some species are very aggressive and persistent, while others are very shy. Finally, some deliver a more annoying bite those results in more itching.

### CLIMATIC CONDITIONS

Dengue was the fastest emerging infection amongst all vector born diseases because of several human and environmental factors. Globally climate change is getting reflected in unusual rainfall pattern leading to surplus rains in some locations, deficient rains elsewhere and untimely burst in rainfall. Studies indicate that the South Indian states are facing perceptible fluctuations in climatic conditions, and possibly the health of people is directly or indirectly affected because of these fluctuations (WHO, 2012). Rise in average temperature, an element of climate change, favours higher breeding and spread of the vectors such as *Aedes aegypti*, and consequently spread of dengue virus. In general, incidences of dengue fever, a mosquito-borne tropical disease (*Flavivirus*, an RNA virus of the family *Flaviviridae*), are increasing fast resulting in higher morbidity and mortality in humans worldwide, particularly in tropical and subtropical countries. More than 2.5 billion people of the global population are at risk and 50-100 million Dengue infections per year are likely. Earlier in India, although Dengue Fever was recognized as a classical disease with high morbidity, but no mortality, the disease was mainly restricted to urban and semi-urban areas because of the favourable breeding sites for the vector *A. aegypti*. During the past few years, the frequency of Dengue Hemorrhagic Fever (DHF) has increased remarkably in South India (WHO, 2003). The density and distribution of the vector depend on a few vital environmental factors such as season, temperature, rainfall and humidity that vary with latitude and altitude (Johansson et al., 2009, WHO). The life span of the vector is strongly influenced by temperature and humidity and it survives best between 16°C and 30°C and relative humidity of 60-80%. The abundance of *A. aegypti* fluctuates with unusual rainfall pattern and water storage, as it breeds well in the open containers in and around houses. Manmade factors such as environmentally negligent developmental activities also cause outbreaks at new locations (Ilkal, et al., 1991) Tamil Nadu gets rains in four spells:



winter (January– February), pre-monsoon (March– May), monsoon (June– September) and post-monsoon (October–December). The northeast monsoon, starting in October and lasting up to December, is marked with heavy rainfall, whereas the southwest monsoon, from June to September, accounts for moderate rainfall. Rainfall is scanty in the premonsoon period. Of the total annual rainfall (945 mm) in the state, 48% is received during the northeast monsoon, 32% during the southwest monsoon and the rest during other seasons (Chandran, et al., 2014-15).

Rainfall critically influences several crucial issues of people. Many towns and cities in Tamil Nadu and Puducherry are dependent on rivers for drinking water and deficit in rainfall reduces drinking water supply. Three consecutive rain-deficit years (2011, 2012 and 2013) and delayed monsoons have created drought-like situations; overall shortfall was 20–23% of the annual average rainfall (Venkat, et al., 2014). Some parts of the state, people are forced to store water in open containers (Stalin, 2012). An important, but indirect effect of this seems to be proliferation of *A. aegypti*, the vector spreading dengue. In 2010–2012, outbreaks of dengue/ chikungunya-like illnesses with severe clinical manifestations were reported from several districts of Tamil Nadu, such as Chennai, Tirunelveli, Virudunagar, Theni, Madurai, Thiruvallur, Vellore and Dharmapuri. Although the exact number of fever cases or number of fatalities is not available, approximately few hundred thousand people were affected (Wilson, et al., 2014, Sudeep, et al., 2011).

## **WEATHER**

Weather, the short-term condition of climate, has a much more direct and tangible impact on daily life. Since earliest times, weather has been fundamental to the success of human activities, from agriculture to seafaring, from warfare to leisure. The universal belief in weather deities, the prominence of weather events in folklore, and the ubiquitous preoccupation with weather signs and portents are evidence that an awareness of weather.

## **WASTE PRODUCTS**

### **Septic tanks**

Most of the 1.2 lakh septic tanks support mosquito breeding. Open vent pipes, open outlet pipes and damaged slabs make the septic tanks conducive for mosquito entry and

breeding. The outlet pipes are either connected to open drains or open to form a pool, which support profuse breeding of mosquitoes. This is a technical problem as the liquid portion of the effluent needs to be let out, making such outlet pipes inevitable. When such pipes are diverted to the open ground, mosquitogenic pools are created. Mosquitoes breed in septic tanks and in piles of sewage. At some places, rain water that has stagnated for more than 10 days could end up mixing with overflowing sewage. Such pools could turn in to breeding sources leading to more of these mosquitoes coming up.

### Cess pools

Water stagnation in vacant plots and barren lands also supports mosquito breeding particularly when these plots receive sullage water from the houses. Mosquito breeding can be controlled in such situations by (i) spraying larvicides; (ii) channeling water can be drained out into the nearby drains/canals; and (iii) as a permanent measure the vacant plots should be filled to avoid water stagnation.

### Ponds

Due to rapid urbanization, man-made ponds are being converted into residential plots. However, in the periphery of the city, there are a considerable number of ponds, infested with aquatic floating weeds supporting *Mansonioides* mosquitoes, the vector of brugian filariasis. Mosquitoes in these ponds can be controlled by physical removal of weeds and stocking the ponds with weedivorous fishes such as *Ctenopharygodon idella* (Chinese grass carp) and *Osphronemus goramy* (Giant gourami). The fingerlings can be collected locally from the Fisheries Department. An income generating scheme can also be introduced involving the community Entomologists say these mosquitoes enter septic tanks open vents and can breed in lakhs.

### Wells

Wells which were disused remained polluted due to accumulation of debris.

**RESULTS**

Survey of mosquito borne diseases such as Dengue fever, West Nile Fever and Yellow Fever was carried out in Chennai of Tamilnadu (Table 1 and figure 7).

During the study period of four years (January 2011 to December 2014) the number of Dengue, West Nile and Yellow Fever cases observed in Chennai of Tamilnadu.

Age and Year wise distribution of Dengue, West Nile and Yellow Fever cases have been shown in Table 1.

In the Year 2011 - 80 Dengue cases,4 - West Nile cases and 8-Yellow Fever cases(Total - 92) were observed.

In the Year 2012 - 49 Dengue cases,3 - West Nile cases and 13 -Yellow Fever cases(Total - 65) were observed.

In the Year 2013 - 43 Dengue cases,4- West Nile cases and 9 -Yellow Fever cases(Total - 56) were observed

In the Year 2014 - 83 Dengue cases,3 - West Nile cases and 10 -Yellow Fever cases(Total - 96) were observed.

During the study period of four years, total cases Dengue, West Nile and Yellow Fever cases were 92 in 2011,65 in 2012,56 in 2013 and 96 in 2014. There was a gradual increase in dengue in 2011 and 2014 observed in study period of four years.

Selection of local areas such as Parrys, Mint, Sowcarpet, Sevenwells, Basin bridge, Korukkupet, Otteri, Puliyanthope, Vyasarpadi, Tondiarpet, Washermen pet...etc in Chennai because of prevalence waste products, inappropriate drainage system etc. factors favorable for mosquitoes.

All age group of peoples suffer from the disease dengue, Children's and Adults (0 to 20 years) are highly affected with dengue in present study.

West Nile Virus mainly affects in infants (childrens) and aged people (above 60/>30) because they have less immunity.

Yellow Fever also affects all age groups, less in childrens, high in Adults because they acquire Jaundice,Paralysis and Kidney failures.

There is no age limit of acquisition of mosquito borne viral diseases.

The spreading of mosquito disease was observed mainly in rainy season. (july-october).

When compare with other viral diseases such as Westnile and Yellow fever Dengue highly spread in Chennai of Tamilnadu.

Mosquitoes everywhere in Chennai,Tamilnadu recorded second highest Dengue cases in 2014.

#### **DISCUSSION:**

Dengue virus is a member of the Flaviviridae family, which includes a number of neurotropic viruses such as Westnile virus, and Yellow fever viruses.

Dengue fever and Dengue Haemorrhagic Fever (DF/DHF) have become an important public health problem in many states of India in recent years. Remarkable increase in dengue fever and DHF related mortality and morbidity during the last decade has necessitated an effective surveillance system to detect the cases and adopt appropriate control measures against dengue vectors. Very early as 1960s, existence of all the four serotypes of dengue virus was proved in Tamil Nadu, but only after 1990, several outbreaks of DF/DHF were reported. Dengue was initially considered as urban problem; but now it has penetrated into rural areas also, due to various changes in the environment. The presence of stagnating water after rainfall favours breeding of the mosquito vector resulting in an increased incidence of dengue.

In this study, we observed overall during the study period of total 2011-2014 for the cases in dengue, west Nile and Yellow fever cases were 92 in 2011; 65 in 2012; 56 in 2013 and 96 in 2014. There was a gradual increase of dengue cases from 2011 to 2014 observed in study period of four years.

It indicates an increase in dengue virus activity, raising the question whether dengue is emerging/re-emerging as a major health problem in Chennai. Gradual increase is probable

secondary infection in a developing country like India could be attributed due to multiple serotype infection which again raises concern for the increase in the incidences of the more serious Dengue Shock Syndrome and Dengue Haemorrhagic Fever DHF/DSS.

Though dengue affects human beings of all age groups worldwide, in some parts of the world it is mainly seen as a pediatric public health problem. However, in our study, adult population (10 to 20 years) was the most affected age group when compared to other age groups.

Month wise (season) analysis of dengue infections showed that dengue cases increased in number from the month of July to October each year. Seasonality of transmission of dengue infection was more during cooler months (rainy season), with an increase in prevalence soon after monsoon. The presence of stagnant water after rainfall favors the breeding of mosquito vector, resulting in an increase in dengue cases in post monsoon months. Hence, vector control measures should be implemented during the monsoon and post monsoon months. However, positive dengue cases were also detected even during dry months indicating the year-round activity of the mosquito vector. In India, there is no separate mosquito control programme as it is linked with sanitation and solid waste disposal, which is carried out by municipalities or corporations. Most of the municipalities/corporations are unable to undertake mosquito control due to various reasons and seek the help of other organizations such as the Vector Control Research Centre (VCRC), which has developed Master Plans for the control of mosquitoes in Chennai.

Yet, the factors identified in the present study have inevitable roles in the overall Dengue outbreak. This study also highlights the need for a detailed study taking into account various other factors, such as human population and mobility, urbanization rate, waste management, water supply and distribution and densities of vector mosquitoes. It is felt that strategy to deal with such vector-borne diseases has to be an integrated one, developed from environmental and health management perspectives rather than only from the standpoint of health management and therapeutics. Dengue continues to spread to newer areas, newer populations and in increasing magnitude. This study examined rainfall, power supply and alerts from surveillance system as the factors for predicting dengue occurrences. The study also highlighted the importance of reliable and precise data for preparing a prediction model

for the epidemic diseases. Further detailed studies could reveal the relations of climatic, environmental and human-induced factors with dengue outbreaks, which would help in evolving strategies to deal with likely outbreaks well in advance. Surveillance programmes and appropriate models capable of detecting rise in vector outbreaks, strains, or disease emergence well in time are crucial.

**CONCLUSION:**

This study showed a high number of dengue patients as well as a gradual increase in the dengue infection over the study period of four years. This increase in dengue disease observed may be a warning sign of the future epidemics which is again a serious matter of concern. Hence involvement of good laboratories for early and prompt diagnosis of dengue infection, coupled with vector control programmes and inducing awareness among the public, is needed in combating future epidemics of dengue and related mortality.

Molecular studies on the circulating serotypes and their genotypes may be of help in addressing the probabilities of Dengue, West Nile and Yellow Fever Virus incidence in future. Involvement of many laboratories in diagnosis of dengue coupled with general awareness among the public and constant vigilance by the health care officials could go a long way in combating dengue.

Till now there are no specific treatment of Dengue, West Nile and Yellow Fever viruses. We go for antiviral drug therapy.



**Table 1:** The total number of Dengue, West Nile and Yellow Fever cases reported in Chennai, Tamilnadu during the year 2011 to 2014.

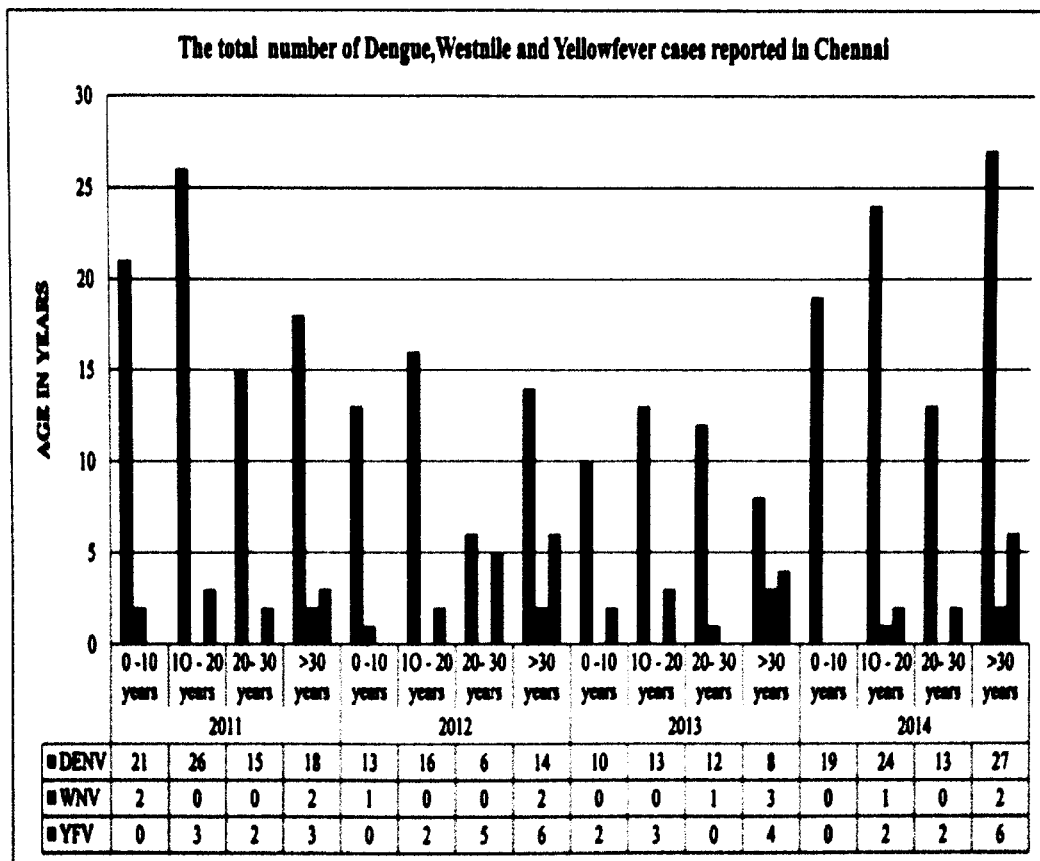
YEAR	AGE (IN YEARS)	NO.OF CASES OBSERVED			TOTAL NO OF CASES
		DENV	WNV	YFV	
2011	0 -10 years	21	2	0	23
	10 - 20 years	26	0	3	29
	20- 30 years	15	0	2	17
	>30 years	18	2	3	23
2012	0 -10 years	13	1	0	14
	10 - 20 years	16	0	2	18
	20- 30 years	6	0	5	11
	>30 years	14	2	6	22
2013	0 -10 years	10	0	2	12
	10 - 20 years	13	0	3	16
	20- 30 years	12	1	0	13
	>30 years	8	3	4	15
2014	0 -10 years	19	0	0	19
	10 - 20 years	24	1	2	27
	20- 30 years	13	0	2	15
	>30 years	27	2	6	35

DENV: Dengue Virus

WNV : West Nile Virus

YFV : Yellow Fever Virus

Figure 7: Graphical representation of the total number of Dengue, West Nile and Yellow fever cases reported in Chennai.



Note: Case study in Chennai some selected areas (Corporation of Chennai hospital, BRS garden, George town & Park town (sigma clinical laboratories))