

Spatial and Seasonal Distribution of Leptospirosis in Chennai City

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ABSTRACT

Climate change affects disease dynamics directly and indirectly. One of the greatest challenges in the field of climate epidemiology is to quantify the impacts of climate change with regard to the repertoire of diseases and conditions associated with them. This study aimed to analyze spatial and seasonal distribution of leptospirosis in Chennai City. It has become a public health problem in the world, especially in developing countries which have tropical and subtropical climate. Correlation analysis between rainfall and disease incidence cases revealed very highly positive correlation of 0.958 ($p < 0.001$). The variation of disease incidence among zones in different seasons varies significantly ($P < 0.01$).

Keywords: Leptospirosis, Seasonal and Spatial Analysis, Rainfall, Correlation

I. INTRODUCTION

Leptospirosis is a fairly uncommon bacterial infection caused by a strain of *Leptospira*. It is most commonly transmitted from animals to humans, when people with unhealed breaks in the skin, come into contact with water or soil that has been contaminated with animal urine, the bacterium can also enter the body through the eyes or mucous membranes. Typically the animals that transmit the infection to humans include Rats, Skunks, Opossums, Foxes, Raccoons and other vermin. Although more common in tropical, non-tropical areas and urban conglomerations with low levels of sanitation are seeing more cases, especially during the summer and autumn months. Most of the urban areas and larger cities are affected by Leptospirosis in the developing world. India has a unique climatic regime with two monsoon seasons (south-west and north-east), two cyclone seasons (pre- and post-monsoon), and hot weather season. Climate changes will have a direct impact on all environmental factors which are directly or indirectly related to human health.

Leptospirosis is an infectious disease, which determines economic losses in livestock, mainly characterized by reducing the reproductive performance in herds (Aguiar et al., 2010). Human leptospirosis is a waterborne

disease caused by spirochetes of the genus *Leptospira*. Currently, it is considered the most common widespread bacterial zoonosis and a growing worldwide public health problem (Adler & de la Peña Montezuma 2010). Leptospirosis is a disease with a very complex ecology involving the bacteria, the animal reservoirs, humans and their surrounding environment. Pathogenic leptospires are transmitted to humans by direct or indirect contact with infected urine, blood or tissue of carrier animals or urine-contaminated water, soil or food (Bharti et al. 2003). Moreover, leptospirosis has emerged to become a health threat in urban centres (Ko et al. 1999; McBride et al. 2005). Rapid and spatially disorganized process of urbanization throughout the developing world has created unhealthy physical and social urban environments (Sclaret. 2005). Environmental data, geographic information systems (GIS), spatial statistical analysis, and predictive risk maps have been used for the investigation and management of a range of infectious diseases including schistosomiasis (Clements et al. 2006), malaria (Noor et al. 2008), trachoma (Clements et al. 2010) and Rift Valley fever (Clements et al. 2007). These maps identify geographic areas with high disease prevalence and/or risk of outbreaks, and are useful for guiding allocation of scarce public health resources to explore associations between seropositivity and individual-level risk factors

(demographics, and exposures at home, work, and during recreation). Geo-referenced environmental data were used to explore associations between seropositivity and environmental factors around the home. The study design, study population, sampling technique, laboratory methods, and results have been described in detail in a recent report (Lauet al. 2012)

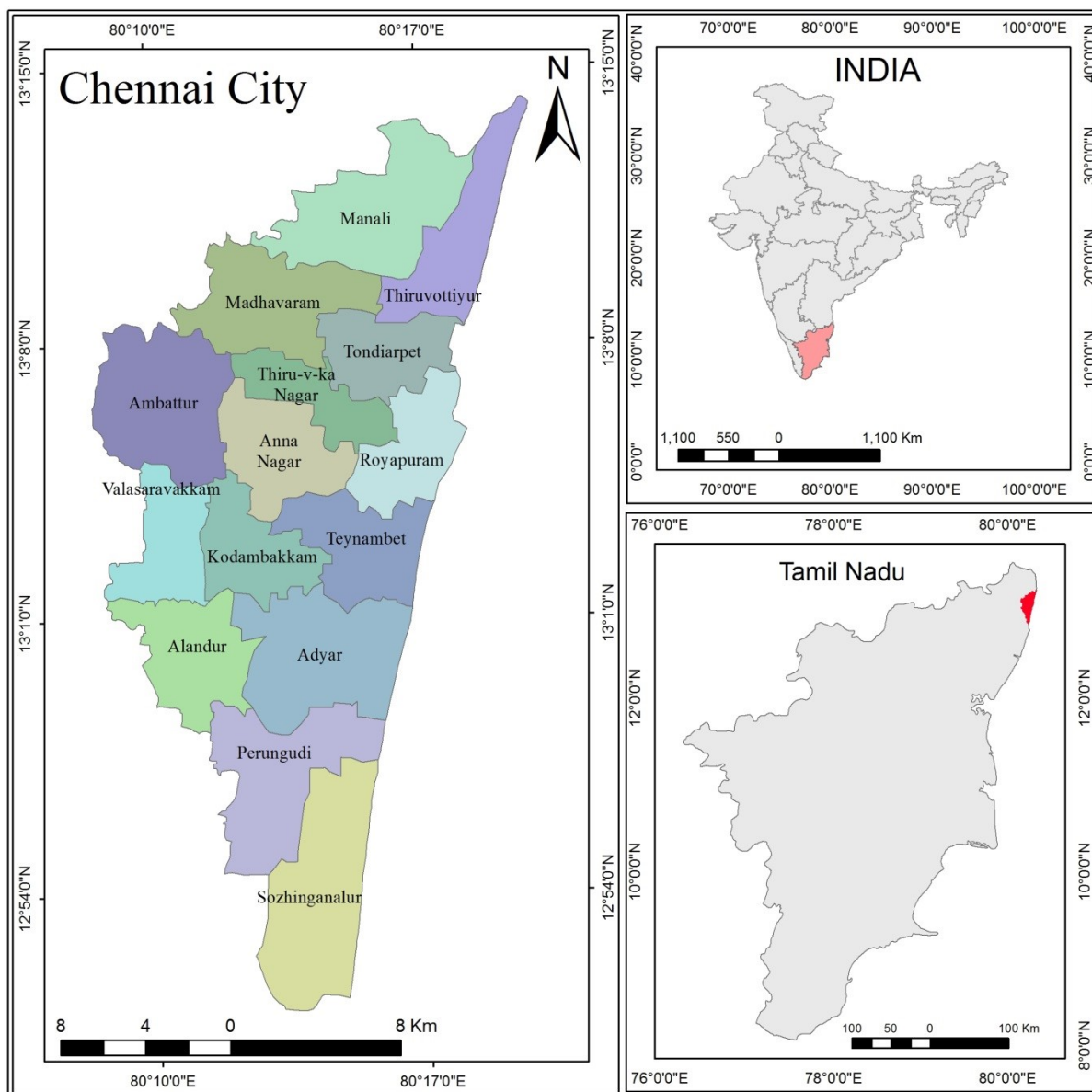
Sehgal *et.al.*, (2002) studied a flooded affected area to examine the possibility of leptospirosis being the cause of the outbreak. Serum, samples were taken from a few such patients and tested positive cases. It revealed that outbreak of leptospirosis in the flooded villages was affected highly. The host carrier might have existed in the animal population. They found out the main reason is cyclone and floodwater is changed the environment drastically making it conducive for transmission of infection. Climate change can affect various ecological factors that are likely to drive an increase in the overall incidence as well as the frequency of outbreaks of leptospirosis. The data have been the study like urbanization, rainfall, flooding, temperature, poor sanitation and inadequate waste disposal, exposure of animals and population growth. The findings shows that to reduce this disease burden the combination of climate change, flooding, population growth and urbanization will almost certainly lead to increase in the global burden of disease from leptospirosis. Areas at particularly high risk include urban slums, low-lying areas and small island states (Colleen L. Laua. *et al.* 2010). GIS spatial analysis in conjunction with more traditional epidemiological analysis can be a powerful tool in identifying risk factors for infectious diseases. The potential risk factors for canine leptospirosis infections and to perform a spatial analysis to investigate which aspects of the landscape and land use patterns are important in the transmission of leptospirosis (George S. Ghneim *et. al.* 2006). An epidemiologic study to determine potential relationships of environmental context to human exposure to *Leptospira* indicates that the Human exposure to *Leptospira* sites with contrasting ecological features depended more on environmental context than the prevalence of infection (Johnson *et al* 2004). The agents of environmental sanitation conditions or socio economic situation and also shows that *Leptospira* is inversely associated with education level, which in turn could reduce the contact between pathogenic *Leptospira* and urban populations (Dias *et. al.* 2007). The possibility of rains and flood an outbreak of

leptospirosis and describe the clinical illness was suspected in which the stray dogs are more likely to transmit leptospirosis than domestic/licensed dogs. (Karande, *et al.* 2000). The transmission of *Leptospira* infection in urban slum communities can be studied by analysing the factors like urbanization, rainfall, flooding, temperature, poor sanitation and inadequate waste disposal, exposure of animals and population growth (Maciel *et al.* 2007).

II. STUDY AREA

Chennai district, formerly known as Madras district, is an administrative division of the state of Tamil Nadu, India. It is the smallest districts of the state but has the highest human density. Chennai district is a capital city of the state of Tamil Nadu. Chennai is a coastal district lies between 12° 09' N and 13° 09' N of the latitudes and 80° 0' 12'' E and 80° 0' 19'' E of the longitudes (Map 1). It stretches for 25.60 km, along the Bay coast, from Thiruvanmiyur on the south to Thiruvottiyur on the north. It runs inland in a rugged semi-circular fashion. It is bounded on the east by the Bay of Bengal and on the remaining three sides by Kanchipuram and Thiruvallur districts. Chennai city covers an area of 178.2 km².

The Chennai city zones at highest risk are those where multiple risk factors for leptospirosis are likely to co-exist, such as the combination of increasing flooding risk, rising temperatures, overcrowding, poor sanitation, poor health care, poverty, and an abundance of rats and other animal reservoirs. Environmental and ecological imbalance is arising in the coastal area due to over exploitation of groundwater due to increase of settlements, hotels, tourism centre and many industries which leads seawater intrusion, posing a major problem in the coastal plain. With the increasing risk of flooding and continuing population growth and urbanisation, these areas are likely to experience an upsurge in the scale and severity of leptospirosis epidemics. Leptospirosis is usually a seasonal disease that starts at the onset of the rainy season and declines as the rains recede. Sporadic cases may occur throughout the year. In India the disease has been found more commonly associated during post-monsoon period. In natural disasters such as floods it may assume epidemic potential.



Map 1

ANOVA analysis was performed to analyze the zone wise variation in incidence cases.

III. Methodology

The data base for the study is based on the Primary and Secondary Sources. In the Primary data collection the 200 random sample has been adopted to acquire the details of occupation structure, address, age groups, symptoms and Epidemiological profile like rainfall, contact with contaminated environment and history of animal contact were collected to know about the epidemiological, environmental and ecological factors of the study area. The month wise Rain fall data for the period from 2014-2016 have been correlated with the leptospirosis disease incidence for the same period.

IV. SPATIAL DISTRIBUTION OF DISEASE

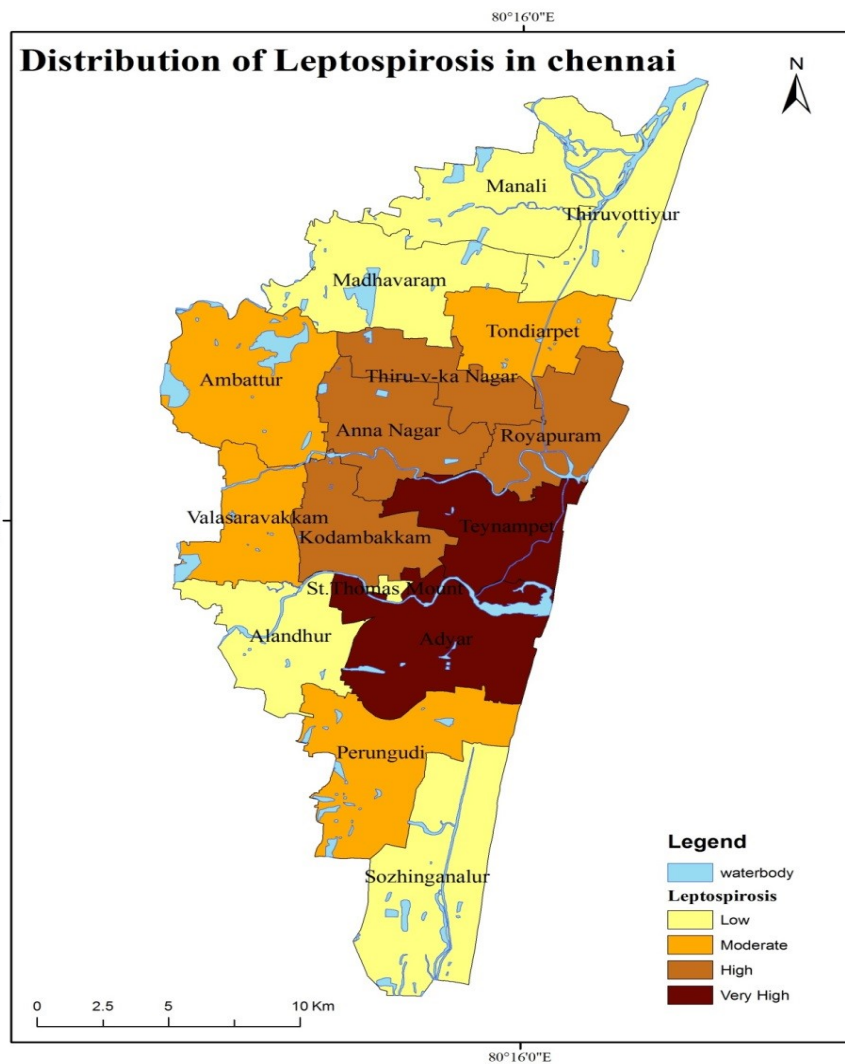
Spatial distribution is important in analysing and evaluating risks to health, particularly those relating to the environment and the socioeconomic profile of the population. In study area 200 cases were geo-referenced in different zones of the city. The analysis has been carried out from 2014 to 2016. The most affected period is the 2015, during the year the rainfall is heavily increased to compare the 100 years before of annual rainfall. Over all from the analysis it has been found out that Zone of Adyar and Teynampet is the most affected by Leptospirosis. Manali, Thiruvottiyur and

Sozhinganalur are least affecting by the Leptospirosis. These areas are situated close to Coastal plain areas. Furthermore the analysis has been carried out seasonally winter season, Pre-Monsoon season, Monsoon season and Post-Monsoon season. Out of the 200 cases, 31.5 percent presented Fever, 24 percent Body pain, 23 percent Head Ache, 8.5percent Joint pain, 7.5 percent Myalgia, 3.5 percent Jaundice and 2 percent vomiting, the cases found predominantly from central part of the Chennai city, the area surrounding the hospital. The correlation between disease incidence and rainfall indicated a high positive correlation of 0.958 at one percent level of significance ($P < 0.01$). Similarly the analysis of variance also revealed the significant variation ($P < 0.01$) in the incidence of disease among the zones in different seasons. The analysis shows that more incidences were affected during monsoon period and post-monsoon period and lowest incidences were affected during winter season. The highly risk working groups are agricultural workers such as rice field planters, sugar cane and pineapple field harvesters, labourers engaged in drainage cleaning operations and livestock handlers are subjected to exposure with *leptospire*s. Other occupational high risk groups are – Fishermen, sewer workers and all those persons who are liable to work in rodent infested environment. Lorry drivers as they may use contaminated water to wash their vehicles and masons, who may come in contact with the organisms while preparing the cement and sand mixture for construction work with contaminated Water. The distribution of the leptospirosis from the table 1 depicted that more incidences were affected in central part of the city zones like Adyar, Teynambet, Kodambakkam, Thiru-vi-kanagar and Anna nagar.

Table: 1. Incidences of leptospirosis in different Zone wise

Name of the Zone	Zone	Winter	Pre-monsoon	Monsoon	Post-Monsoon	Total (%)
Thiruvottiyur	I	0	0	2	2	1.2
Manali	II	0	0	2	0	0.7
Madhavaram	II I	2	2	2	0	1.7
Tondiarpet	I V	4	0	5	10	5.5
Royapuram	V	7	7	8	8	8.6
Thiru-v-ka Nagar	V I	8	8	10	14	11.5
Ambattur	V II	4	1	2	5	3.4
Anna Nagar	V II I	8	2	14	10	9.8
Teynambet	I X	10	9	13	21	15.2
Kodambakkam	X	7	3	19	15	12.6
Valasaravakkam	X I	3	3	7	1	4
Alandur	X II	0	0	1	3	1.2
Adyar	X II I	11	11	23	23	19.5
Perungudi	X I V	1	3	5	4	3.7
Sozhinganalur	X V	1	0	1	3	1.4

The Map 2 shows clearly the total incidence of leptospirosis during the study year (2014-2016). In central part of the zones of Chennai city is very highly in Adyar and Teynambet) and highly in Royapuram, Anna Nagar, Kodambakkam and Thiru-v-ka Nagar affected by the leptospirosis in the study period. Tondiarpet, Valasaravakkam, Perungudi and Ambattur zones are affecting moderately and low cases of leptospirosis in Thiruvottiyur, Manali, Madhavaram, Alandur and Sozhinganalur those are the coastal area because of the no water logging.



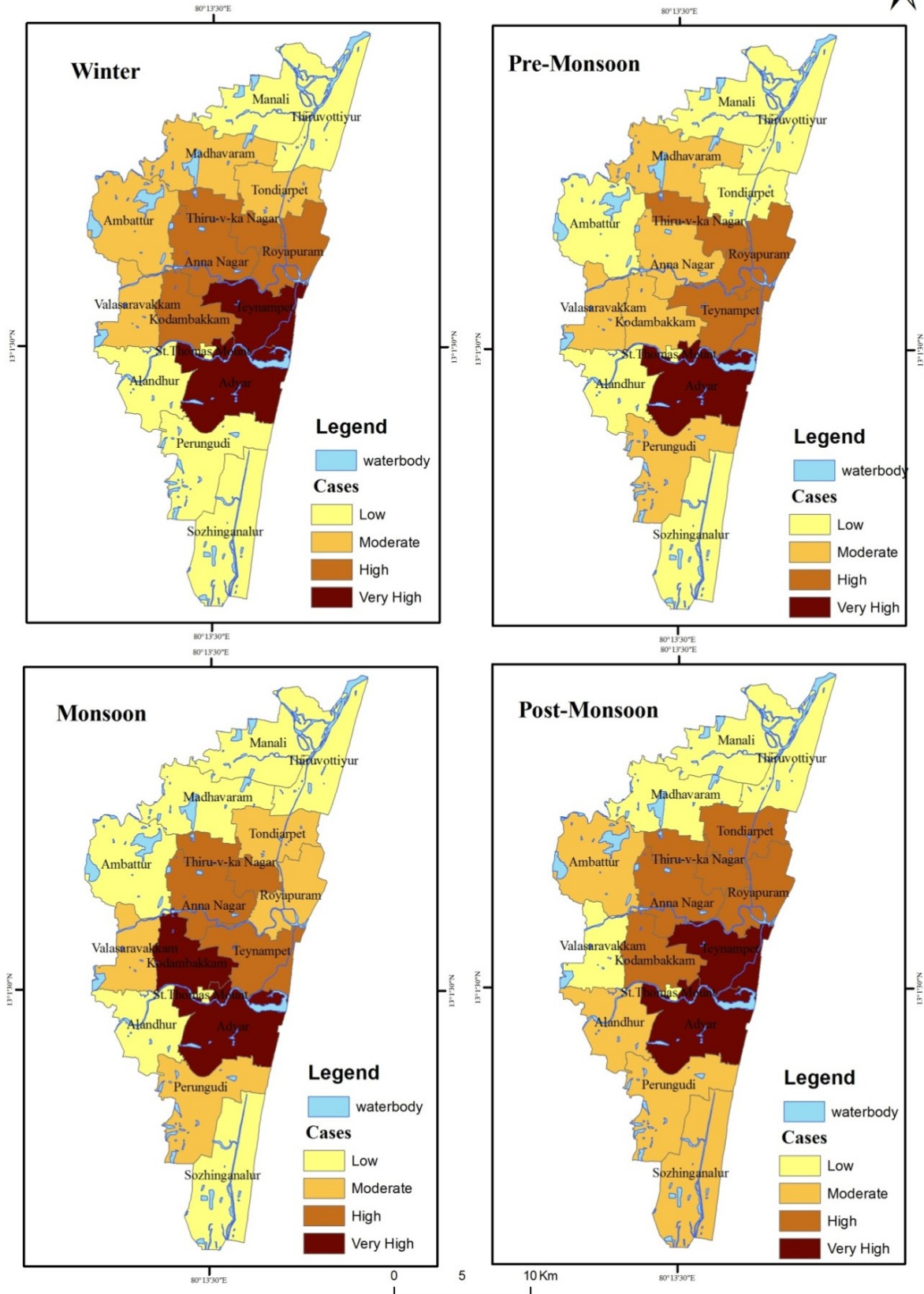
Map 2

V. SEASONAL DISTRIBUTION OF LEPTOSPIROSIS

From the collected samples it has been found out that season wise mapped out in Map 3. The analyses were worked out for the four seasons. The four seasons are 1. Winter season (January and February), 2. Pre-Monsoon season (March to May), 3. Monsoon season (June to September) and 4. Post-Monsoon season (October to December). When compare to all four seasons, the most affected season is Monsoon and Post-Monsoon period. This showed that even outside of the period of flooding, the people living in these regions continued to present risk factors for the disease to appear and the incidence of leptospirosis increased in the regions close to riverbank highways and reservoirs, probably because of flooding in these locations. During the period of least rainfall, the moderate incidence was in Royapuram and Teynampet,

while during the rainy season, the highest incidence was in Adyar. Overall this four season maps are clearly defining the Central part of the city is having the highest risk factor of affecting the leptospirosis disease, because of the regions close to riverbanks and the people living most of the shantytowns presented were randomly distributed and located both on the periphery and in prime Zones of the city. The Coovam river getting waste water from the North and Middle zones of the city, quality of water is saline so that the surrounding areas also in poor quality. It is an area of impounded water spread areas extent and often with a regulated flow of water. It includes man made /tanks/canal, besides natural lake, rivers/streams. Numerous tanks located in the study area are mainly containing the hydrophytes or shrub/scrub appears with the edges of the sides of the river because of this reason the rodent population is high in the region so the incidences of leptospirosis chances is increased.

Season wise Distribution of Leptospirosis in Chennai



Map 3

From the observed data it has been found out that different view of the distribution of disease in Chennai city. In the present study, the distribution prevalence of leptospirosis in among the cases registered, 57.3% were men, 50.5% were in the age group from 0 to 30 years, 85.3% Spatial and seasonal analysis on leptospirosis presented fever, 59.0% acquired the infection at home and 35.7% had had contact with a rodent. It has been shows that more incidences were affected in the Chennai city. The thematic maps of incidences divided into four seasons in order to view the spatial patterns. The highest correlations were in zones with high and low incidence in the river peripheral and central regions, respectively. Mortality was not represented in this collected data because of its random pattern. In Chennai city, north and south zones presented a concentration of good social conditions, the regions located in close to coastal plains presented low or no correlation.

On the incidence map for the winter season, the very highest rates were located in the zones close to the ICF, Otterinallar reservoir, Coovam and AdyarRiver. The central region presented high incidence of the disease, except in the valasaravakkam zone and low & moderate incidences in northern and southern part of the Chennai city. During the Pre-Monsoon period, east central part f the corporation zones were high incidence, correlating with the areas of worst socioeconomic level with the Adyar and Royapuram zones. During the Monsoon and Post-Monsoon period was having most number of incidences in the period. In the Monsoon period, very high incidences in the Adyar and Kodambakkam close zones to Adyar River and except the Alandur. Finally during the post-monsoon period, the very highest incidences were located in the Teynampet and Adyar. The southern part of the city zones presented moderate incidences of the disease. The incidence of the leptospirosis was concentrated in regions with worse living conditions, but without any formation during either period near to mostly Reservoirs, Adyar and Coovam River.

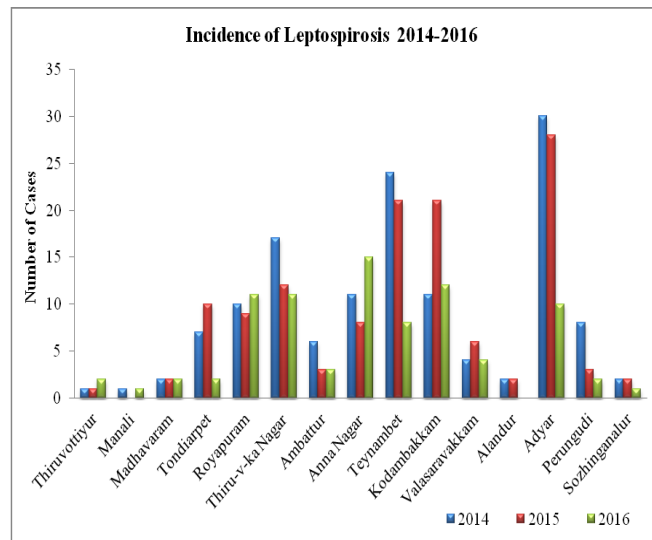


Figure 1.

From the collected samples it has been found out that year wise mapped out in fig. 1 from the analysis maps were prepared for 2014 to 2016. The most affected zones are Adyar, Teynampet and Kodambakkam because of that area are near to River edge of Adyar. And overall result of this analysis more Leptospirosis cases in the East Central part zones of the Chennai city is highly affected compare to other zones. In 2014, Adyar and Thiru-v-ka Nagar is most affecting by Leptospirosis because of the Adyar river is near to the zones. Least affected areas are Thiruvottiyur, Manali, Madhavaram, Alandur and Sozhinganalur. In 2015, due to the heavy rainfall cases of leptospirosis is highly increased in along the river zones. Throughout the year Monsoon and Post-Monsoon season these areas are affecting by flood the main areas are like Adyar, Teynampet, Kodambakkam and Thiru-v-ka Nagar and also marshy land of Chennai city. In 2016 also reflect the flood effects, during the winter and pre-Monsoon season is also recorded more cases in Adyar and along Coovam river areas.

VI. DISCUSSION

The present study confirms that the year 2014-2016, an out break of leptospirosis did occur in patients who were admitted in hospitals due to following reasons like heavy rainfall and flooding. Since in the early phase of leptospirosis was abrupt onset of fever can be the only identifiable symptom in many cases. The results from the present study showed that almost half of the cases became infected in the home, thus indicating the

precautionary steps has to take by the public Health Department, Corporation of Chennai. From the sample data analysis it has been clearly noted that the most affected was male adults (students Community) by the disease. During the winter and Pre-Monsoon period, the cases appeared more and coincided with the areas of unhealthy social and housing conditions. In 2015, November 25th to December 4th there was a unusual rainfall within short period due to this extreme flooding the incidences of leptospirosis is highly endemic affected zone is Adyar next to the Teynampet in Chennai city. During the period of least rainfall, the highest incidence was 30.5% cases, while during the rainy seasons the highest incidence was 69.5% cases in Chennai city. So our result clearly shows that incident of leptospirosis once again re-emerging in Chennai it may due to lack of awareness in public, especially in urban slums and water contamination areas during Monsoon and Post-Monsoon season because of improper drainage system.

VII. CONCLUSION

The results from the present investigation made it possible to identify geographical areas in which the residents shared similar socio-economic, environmental and living conditions. Identification of these homogenous areas enables decisions regarding specific strategies and interventions for the needs of people living in these areas. It also allows prioritization of resources for groups with greater vulnerability, there by contributing towards diminishing health care inequalities. Since there are limitations on resources within public administration, breaking down the statistics in this manner may contribute towards prioritizing the investments in the most problematic areas. The periphery of the city requires appropriate urban development and improvement in its sanitary conditions. This characteristic makes it possible to suggest that the incidence of this disease may be a social indicator. Leptospirosis is found more frequently in areas where addresses are irregular, thus resulting in great lack of information. The treatment given to addresses in shanty towns, camps and invaded areas is a problem that deserves special study.

We recommend that all patients with fever of more than 5 days of duration should be investigated for leptospirosis especially in endemic areas. The actions needed go from simple manipulation and monitoring of the environment, such as cleaning of drainpipes and

adequate disposal of urban garbage, tour ban development of shantytowns, with drainage and canalization of rivers and streams, thereby preventing occurrences of flooding. In addition, a rodent control program should be implemented in areas around homes and within work environments, even during drought periods to decrease not only leptospirosis but also other communicable diseases.

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