DENGUE FEVER AND CLIMATE: ANALYSIS IN THIRUVANANTHAPURAM

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Abstract—Thiruvananthapuram, the capital district of Kerala state, has witnessed an alarming rise in dengue fever cases since 2010. An approach to analyze spatial and temporal trends was not yet undertaken in the State. The objective of this study was to geographically map the confirmed cases and to determine relation to climatic correlates. Epidemiological data and meteorological data from January 2011 to June 2014 were obtained from Health Service Department and Indian Meteorological Departments respectively. A total of 8279 cases were analyzed. The monthly dengue fever occurrence, climatic variables such as humidity, temperature and rainfall showed seasonality. A temporal trend was found between the occurrence of the cases and rainfall every year. The findings of this study showed that timely geospatial analysis of available routine public health data could be useful in the prediction and control of potential outbreaks in the district.

Index Terms—Climate, Dengue, Geospatial, Kerala.

I. INTRODUCTION

Globally, 2.5 billion people are now at risk for dengue (the fastest emerging arboviral disease) and 50-100 million cases occur every year. [1] It affects about 100 million people annually in the tropical countries [2] and 3.97 billion is the upper limit of population at risk.[3] In the past 50 years, there has been a 30-fold increase in dengue cases world-wide.[4]

India has been undergoing rapid changes in urbanization with its expanding population. This has caused a raise in the overall risk for climate change and hence, changes in relationship of health with climate change.[5] In India, control of vector-borne diseases is emerging as a serious public health problem.[6] The country has also been witnessing an increase in the incidence of dengue fever since 2001. Kerala is one of the endemic states of dengue fever (DF) in India.[7] Since 2006, the state has witnessed a rise in the yearly dengue cases. Kerala had contributed about 9.2 percent cases in the year 2010.[8] The Capital of the state, Thiruvananthapuram district is endemic to dengue fever and reports two-thirds cases in Kerala.[8], [9]

With no vaccine or therapy to treat dengue, the only options against dengue are the vector control measures.[10] Precipitation, rainfall and mean ambient temperature has been found to have significant relation with incidence of dengue fever.[11] The amount of precipitation largely affects the breeding sites for mosquitoes.[12]–[16] The larval density data is considered more efficient in real-time indication of a future epidemic based on occurrence of asymptomatic infections.[15] It is also necessary to have an integration of human behavioural control, environmental control and effective vector surveillance for effective control of DF outbreak.[17] This district has witnessed an alarming rise in dengue fever cases since 2010. An approach to analyze the spatial or temporal trends was not yet undertaken in this part of the State. Hence this study focused on dengue fever occurrence in Thiruvananthapuram district with a geospatial perspective and analyzing its correlation with climatic factors would help to identify high-risk areas for implementing targeted interventions.

II. METHODOLOGY

A. Study Setting

Thiruvananthapuram district in Kerala is located between North latitudes 8º17’ and 8º54’ and East longitudes 76º41’ and 77º17’. The district has an area of 2192 square kilometers, with a population size of 33,07,284 (as per 2011 census). The climate of Thrivananthapuram district is generally hot-tropical. The forest covers affect the climate and rainfall. The Arabian Sea across the west-side contributes to a higher humidity, which is maximum during the South-West monsoon season which extends between June to September. The South-West monsoon season is the primary rainy season with an average annual rainfall of 1500 mm. The second rainy season extends from October to November from the North-East monsoon. The winter season extends from December to February while the summer season is from March to May.

B. Data Collection

Dengue Case Data

Dengue is a notifiable disease in Kerala. All laboratory-confirmed cases are reported to the Health Service Department. Permission was sought from the Director of Health Services to use this data for analysis.

Meteorological Data

Monthly meteorological data including mean maximum temperature; precipitation and relative humidity for the period of interest (January 2011 to June 2014) were obtained for Thiruvananthapuram district according to the existing local meteorological
station coverage. Data was collected from all the four stations in the district.

C. Data Analysis
All the addresses of the reported dengue fever cases were geo-coded using Google Earth. Latitude and longitude coordinates were obtained for each case. The .kml file was then imported to Q-GIS to obtain a point shape file. Analysis of dengue fever occurrence was done based on age, sex and block-wise distribution for the whole study period (January 2011 to June 2014).

The data collected was stored in the computer after receipt from the Health Service Department with password encryption of the file. Identifiers were removed and anonymous data were used for analysis. Ethical clearance for this study was obtained from Institutional Ethics Committee (IEC) of Sree Chitra Tirunal Institute of Medical Sciences and Technology (SCTIMST), Thiruvananthapuram.

R software (http://www.r-project.org/) (version 3.0.2; R development Core Team) and SPSS (version 21) were used for data analysis. Quantum GIS (http://www.qgis.org/en/site/) was used for geospatial mapping and analysis.

III. RESULTS

A. Dengue Cases
A total of 8279 cases were analysed in Thiruvananthapuram district during the years 2011 to 2014. The year 2013 witnessed the highest number of reported cases while 2011 had the lowest number of cases reported.

The age-wise distribution showed that greater proportion of the cases in each year belonged to the age group 20-29 and 30-39 years as shown in Figure 1.

B. Meteorological Data
Meteorological data for 42 months (January 2011 to June 2014) was collected. The mean maximum temperature was the highest in the month of April 2013 and the mean minimum temperature was the lowest in the month of January 2012, depicting a tropical climate in the region. The monthly rainfall was the highest in the month of June 2012 and the lowest in August 2013. The monthly average humidity was the lowest in the month of January 2012 and the highest in June 2013.

The Figure 2 and Figure 3 depict the monthly variations in mean maximum temperature, mean minimum temperature, average humidity and average rainfall. The temperature parameters seem to relate closely to rainfall and humidity in each month. Rainfall and humidity showed an upward trend beginning in the month of May, while the mean minimum temperature and the mean maximum temperatures drop. This appears to be closely linked with the rise in dengue cases in the month of June every year.
C. GIS Mapping of dengue cases
All the 8279 cases were geo-tagged using Google Earth. Point maps of reported cases in each year from 2011 to June 2014 were created using Q-GIS software and are depicted in Figure 4. They show higher occurrence in the Corporation area (the urban region of Thiruvananthapuram district). Not many reported cases were found in the eastern areas. The eastern areas are highlands and are sparsely populated.

D. Temporal Analysis
The number of reported cases was the highest in months of June to October across the study period (2011 to 2014).

As the rainfall increased, the number of dengue fever cases were also increasing (depicted in Figure 4 and 5). Temporal trend across seasons revealed rise in the occurrence of dengue fever in the monsoon seasons (both the South-west and the North-east).

IV. DISCUSSION
This study explored distribution of dengue fever cases in Thiruvananthapuram district using geospatial mapping. It aimed at providing useful information for the health system to improve surveillance measures. The significant rise in the number of cases from 2011 to 2013 depicts the emergence of dengue fever as an epidemic in Thiruvananthapuram district. The state of Kerala has witnessed a rise of dengue fever cases since 2010. It has been attributed that climatic changes have been important contributing factor to this trend. Point pattern analysis of diseases is found to be effective in disease surveillance and control, in complementary to other methodological approaches.[18] Recent advances in mapping and spatial analysis have opened large avenues for control and prevention of vector-borne diseases. Here, routine surveillance data was used for spatial analysis.

The unequal distribution of dengue fever cases shown on geospatial mapping indicates the varied occurrence across regions. The highlands showed higher dengue cases per population density for 1,00,000 population. The higher occurrence of cases in the urban areas can be attributed to the fact that Aedes aegypti is closely associated with human habitation, as was evidenced by Anish et al (2011). Our findings also describe that the dengue occurrence was higher in the densely-populated areas. A review by Khormi et al (2011)[19] has stated that climatic factors including rainfall, humidity and temperature is closely linked with mosquito density population. While relative humidity impacts the flight
behaviour of the mosquitoes, warmer temperature affects development and cooler temperatures affect reproduction rates of diseases. Jeefoo et al. (2011) has also reported very high correlation with rainfall and relative humidity of one month before dengue occurrence. This study has inclined a similar relationship between climatic variables and dengue fever occurrence in Thiruvananthapuram district. This was the first attempt to spatially map the dengue fever cases in Thiruvananthapuram district. However, there is scope for further research including the ecological and social characteristics of the population at large.

CONCLUSION

A geospatial analysis of the routine public health data on reported dengue fever cases could be used to map occurrence of an epidemic, which would be a valuable input for resource allocation and control measures.

REFERENCES


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