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Cause Effect Relationship of Dengue: A Mosquito-borne Disease

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Abstract- The mosquito-borne viral disease Dengue has become one of the worst nightmares of the country, of the whole world. Dengue is also called 'Breakbone fever' or 'Dandy fever'. The incidence of Dengue has increased 30 fold over the past 50 years. Symptoms of dengue fever include severe joint and muscle pain, swollen lymph nodes, headache, fever, exhaustion, and rash. Reasons for Dengue and it's prevention are many, among others, and are matter of concern.
Climate is one important driver of the current distribution and incidence of dengue.
The variation in geographic ranges of different places is another driver of dengue.
The rainfall of different places is another cause.
The different income level of people is another cause.
This empirical study does not find any significant correlations between incidences of dengue with factors like population density, rainfall, income level, etc. A conclusive remark in this regard, however, will call for more comprehensive study with extensive and reliable data.
Keywords – Dengue, correlations

I. INTRODUCTION

Dengue, the mosquito-borne viral disease has become one of the worst nightmares of not only in our country India but of the whole world. Dengue is also called 'Breakbone fever' or 'Dandy fever'. The incidence of Dengue has increased 30 fold over the past 50 years. Dengue fever is passed on by a mosquito bit, mostly the AedesAegyptus mosquito (or "tiger mosquito"). There are four types of the dengue virus, and the infection is present in over 150 countries now.

The epidemic of Dengue in India was first reported in Chennai in 1780, and the first outbreak occurred in Kolkata in 1963; subsequent outbreaks have been reported in different parts of India. Since the mid-1990s, epidemics of dengue in India have become more frequent, especially in urban zones, and have quickly spread to new regions, such as Orissa, Arunachal Pradesh and Mizoram, where dengue was historically non-existent. Since 1956, four serotypes of dengue virus have been reported in various parts of the country.The total number of dengue cases has significantly increased in India since 2001. In the early 2000s, dengue was reported in a few southern states, Maharashtra, Karnataka, Tamil Nadu and Pondicherry and northern states, Delhi, Rajasthan, Haryana, Punjab and Chandigarh. It has recently spread tomany other states, including the union territories. Dengue was initially spread in rural areas as in rural area people used stored water where breeding of larva of dengue viruses grew in a large speed. But now dengue is not restricted in only rural areas due to rapid increase in urbanization and climate change dengue has spread in urban areas also. So the expansion of dengue in India has been related to unplanned urbanization, changes in environmental factors, like, changes in rainfall, humidity, global warming, increase of population density and many other factors. Inadequate dengue mosquito breeding control measures have also created favourable conditions for dengue virus transmission. Both Aedesaegypti and Aedesalbopictus are the main competent vectors for dengue virus in India. The number of dengue cases has increased 30-fold globally over the past five decades. Dengue is endemic in more than 100 countries and causes an estimated 50 million infections annually. Nearly 3.97 billion people from 128 countries are at risk of infection.

Symptoms of dengue fever include severe joint and muscle pain, swollen lymph nodes, headache, fever, exhaustion, and rash. People infected with dengue often also experience long-term fatigue.
Dengue occasionally develops into a life-threatening form (known as severe dengue), which causes abdominal pain and vomiting, breathing difficulty and a decrease in of blood platelets that can lead to internal bleeding. About 2.5% of those infected by severe dengue die, and there is no proper treatment of the disease.Many people infected by the virus a first time show few or no symptoms, but they can still contribute to the transmission of the virus if bitten by a mosquito.

The World Health Organization (WHO) estimates that about 40% of the world's population is at risk of being infected with dengue. All age groups are at risk.One recent estimate indicates 390 million dengue infections per year (95% credible interval 284–528 million), of which 96 million (67–136 million) manifest clinically (with any severity

of disease).1 Another study, of the prevalence of dengue, estimates that 3.9 billion people, in 128 countries, are at risk of infection with dengue viruses.2

In late 2015 and early 2016, the first dengue vaccine, Dengvaxia (CYD-TDV) by Sanofi Pasteur, was registered in several countries for use in individuals 9-45 years of age living in endemic areas. At present, the main method to control or prevent the transmission of dengue virus is to combat vector mosquitoes through:

preventing mosquitoes from accessing egg-laying habitats by environmental management and modification;

disposing of solid waste properly and removing artificial man-made habitats;

covering, emptying and cleaning of domestic water storage containers on a weekly basis;

applying appropriate insecticides to water storage outdoor containers;

using of personal household protection such as window screens, long-sleeved clothes, insecticide treated materials, coils and vaporizers;

improving community participation and mobilization for sustained vector control;

applying insecticides as space spraying during outbreaks as one of the emergency vector-control measures;

active monitoring and surveillance of vectors should be carried out to determine effectiveness of control interventions.

Careful clinical detection and management of dengue patients can significantly reduce mortality rates from severe dengue (From Report of WHO). Causes of Dengue is a matter of concern.

Climate is one important driver of the current distribution and incidence of dengue.

The variation in geographic ranges of different places is another driver of dengue.

The rainfall of different places is another cause.

The different income level of people is another cause specifically in prevention of the attack.

II. DATA AND METHODOLOGY

Secondary data of number of Dengue patients State wise and Year wise, Rainfall of those states, Climate and Temperature, Geographical region, Income levels of people have been collected.The Time Series Variation of the data has been studied State wise and it was seen how these variables and Dengue are correlated to each other. A regression analysis between income and number of Dengue affected people has also been carried out. The empirical observations are made based on (i) Graphical Representation of different variables, (ii) Time series calculations and plotting Graphs and (iii) Correlation and Regression Techniques.

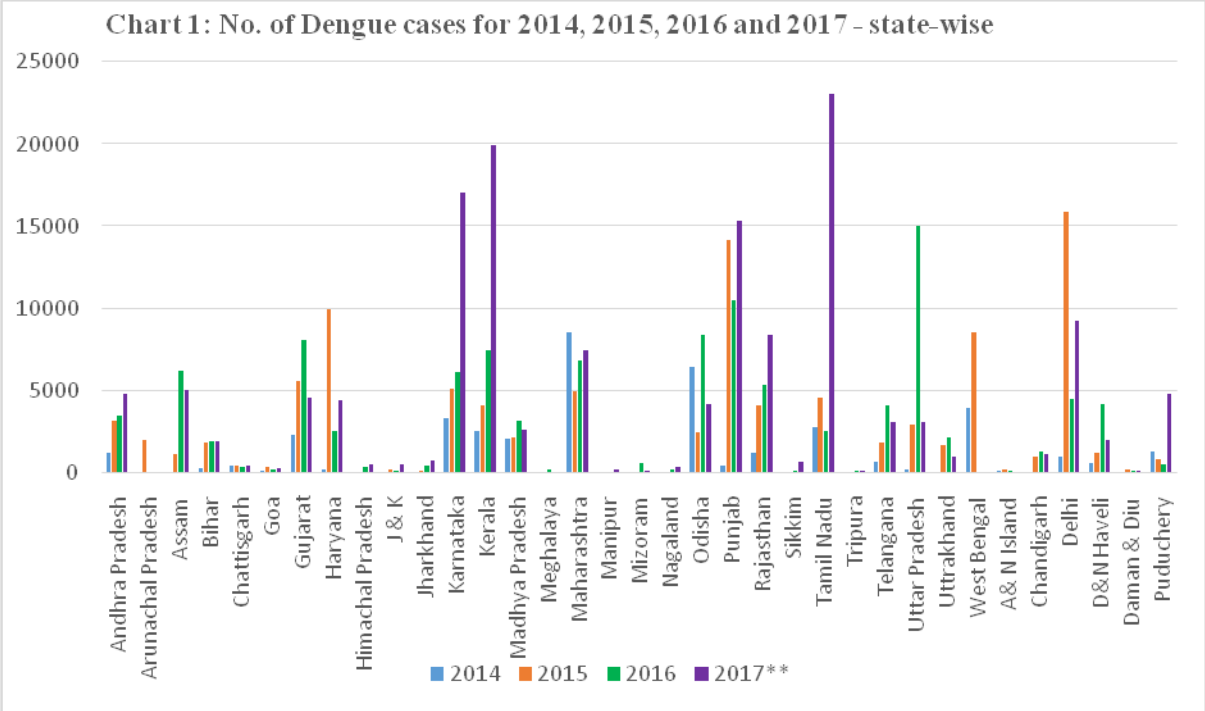
III. EMPIRICAL OBSERVATIONS

Table 1: Dengue Cases and Deaths in the Country since 2010

Sl. No.	Affected States/UTs	2010		2011		2012		2013		2014		2015		2016		2017**	
		C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
1	Andhra Pradesh	776	3	1209	6	2299	2	910	1	1262	5	3159	2	3417	2	4776	0
2	Arunachal Pradesh	0	0	0	0	346	0	0	0	27	00	1933	1	13	0	15	0
3	Assam	237	2	0	0	1058	5	4526	2	85	0	1076	1	6157	4	5016	2
4	Bihar	510	0	21	0	872	3	1246	5	297	0	1771	0	1912	0	1875	0
5	Chattisgarh	4	0	313	11	45	0	83	2	440	9	384	1	356	0	433	0
6	Goa	242	0	26	0	39	0	198	2	168	1	293	0	150	0	257	0
7	Gujarat	2568	1	1693	9	3067	6	6272	15	2320	3	5590	9	8028	14	4564	4
8	Haryana	866	20	267	3	768	2	1784	5	214	2	9921	13	2493	0	4411	1
9	Himachal Pradesh	3	0	0	0	73	0	89	2	2	0	19	1	322	0	453	0
10	J & K	0	0	3	0	17	1	1837	3	1	0	153	0	79	1	485	0
11	Jharkhand	27	0	36	0	42	0	161	0	36	0	102	0	414	1	703	5
12	Karnataka	2285	7	405	5	3924	21	6408	12	3358	2	5077	9	6083	8	17018	5
13	Kerala	2597	17	1304	10	4172	15	7938	29	2575	11	4075	25	7439	13	19912	37

14	Madhya Pradesh	175	1	50	0	239	6	1255	9	2131	13	2108	8	3150	12	2585	6
15	Meghalaya	1	0	0	0	27	2	43	0	0	0	13	0	172	0	42	0
16	Maharashtra	1489	5	1138	25	2931	59	5610	48	8573	54	4936	23	6792	33	7442	41
17	Manipur	7	0	220	0	6	0	9	0	0	0	52	0	51	1	187	1
18	Mizoram	0	0	0	0	6	0	7	0	19	0	43	0	580	0	107	0
19	Nagaland	0	0	3	0	0	0	0	0	0	0	21	1	142	0	357	0
20	Odisha	29	5	1816	33	2255	6	7132	6	6433	9	2450	2	8380	11	4155	6
21	Punjab	4012	15	3921	33	770	9	4117	25	472	8	14128	18	10439	15	15318	0
22	Rajasthan	1823	9	1072	4	1295	10	4413	10	1243	7	4043	7	5292	16	8387	16
23	Sikkim	0	0	2	0	2	0	38	0	5	0	21	0	82	0	659	0
24	Tamil Nadu	2051	8	2501	9	12826	66	6122	0	2804	3	4535	12	2531	5	23035	63
25	Tripura	0	0	0	0	9	0	8	0	6	0	40	0	102	0	123	0
26	Telangana	0	0	0	0	0	0	0	0	704	1	1831	2	4037	4	3061	0
27	Uttar Pradesh	960	8	155	5	342	4	1414	5	200	0	2892	9	15033	42	3032	28
28	Uttrakhand	178	0	454	5	110	2	54	0	106	0	1655	1	2146	4	971	0
29	West Bengal	805	1	510	0	6456	11	5920	6	3934	4	8516	14	22865#	45#	10697*	19*
30	A& N Island	25	0	6	0	24	0	67	0	139	0	153	0	92	0	17	0
31	Chandigarh	221	0	73	0	351	2	107	0	13	0	966	1	1246	0	1094	0
32	Delhi	6259	8	1131	8	2093	4	5574	6	995	3	15867	60	4431	10	9232	9
33	D&N Haveli	46	0	68	0	156	1	190	0	641	1	1154	0	4161	2	1996	0
34	Daman & Diu	0	0	0	0	96	0	61	0	46	0	165	0	89	0	59	0
35	Puduchery	96	0	463	3	3506	5	2215	0	1322	1	771	0	490	2	4746	7
	Total	28292	110	18860	169	50222	242	75808	193	40571	137	99913	220	129166	245	157220	250

* Report upto 04th Oct. 2017, # Report upto 09.11.2016
C=Cases | D=Deaths
Source: NVBDCP



From Chart1 we can make out that Karnataka, Kerala, Punjab, Rajasthan and Tamil Nadu incidence of dengue increased very fast. Maximum increase has happened in the stateTamilnadu.

Data on state-wise rainfall, population density and per-capita income has been sourced from (i) Rainfall data of year 2017, रतमौसमविज्ञानविभाग (पथ्ृिीविज्ञानमंत्रार्य) INDIA METEOROLOGICAL DEPARTMENT (MINISTRY OF EARTH SCIENCES) REPORT NO. ESSO/IMD/HS/R. F. REPORT/01(2017)/23, (ii) Population density data from Census 2011 and (iii) State/UT-wise Per Capita Income at current prices and corresponding percentage change, *For Sl. No. 1-33 — Directorate of Economics & Statistics of respective State/UT.*

It has been noticed and analysed that climate change may contribute to an increase in dengue incidence.Dengue mosquitoes and the viruses are sensitive to the climate condition, environment, rainfall, temperature and humidity of different places. The changes of these factors of different states and places influence the incidence and severity of Dengue attacks. Such conditions include higher temperatures, which can accelerate mosquito development stages and increase dengue transmission, rainfall patterns, producing more standing water – potential breeding sites for mosquitoes. Humidity is another factor which provide favourable conditions for dengue.

In the study, simple correlationshave been found out between no. of Dengue cases and all other factors, like, Annual rainfall. Maximum Temperature, Minimum Temperature, Mean Temperature, Humidity. The observations are summarised as below:

Result 1: The correlation between total no. of Dengue cases in different states and total rainfall is -0.13468, which shows very weak negative correlation, means total rainfall and dengue attacks are not much related, so let us find correlation between the factors monsoon wise.

Result 2. The correlation between total no. of Dengue cases in different states and total rainfall in monsoon time is -0.159128, which shows very weak negative correlation, means total rainfall even in monsoon time and dengue attacks are not much related. It shows that places with less rainfall in monsoon or overall have more tendency of dengue incidence

Interpretation: Rainfall should have positive association with annual rainfall of different places, still we are getting negative correlation as we have taken all states and all states are not severely Dengue affected in India. Also other factors, like, Mean temperature, humidity etc. also have effect on Dengue incidence. Let us take those states which are severely affected by Dengue and find the correlation between the variables.

Result 3. The correlation between total no. of dengue cases with pre monsoon rainfall of states Karnataka, Kerala, Rajasthan, Punjab and Tamil Nadu which are maximum affected is 0.026459, and with monsoon rainfall is 0.038172 for the year 2016. This shows weak positive correlation.

Interpretation: Rainfall and Dengue incidence are not much associated as the other factors of climate also have effect on it. The correlation is positive though weak but it means that out of these most affected states those who have more rainfall, dengue mosquitoes get more suitable breeding sites and more cases are there.

Result 4. The correlation between total no. of Dengue cases in different states and population density (per km sq) is 0.155436 which shows weak positive correlation.

Interpretation: It is obvious that where more population will be there, more number of people will be in contact with the dengue virus, so more number of people will be affected by the disease. Many studies has shown that more number of dengue cases are registered in rural areas than in urban areas. In spite of having low population density in rural areas people are more affected there. This is because in rural areas people very rarely use tap water, they use stored water. The use of water storage utensils provide breeding sites for dengue mosquitoes and leads to increase rate of dengue incidence risk. Areas with more population density both in urban and rural shows more number of incidence of dengue, because the absolute number of people who can contract dengue is high there.

Aedesaegypti, the major vector of dengue viruses, often breeds in water storage containers used by households without tap water supply, and occurs in high numbers even in dense urban areas.

Dengue fever is frequently called a disease of impoverished places and 'is most closely associated with poor populations'. The World Health Organization classifies dengue fever as one of the world's 17 neglected tropical diseases (NTDs) — diseases that serve as 'prox(ies) for poverty and disadvantage'and prescribes population-targeted interventions to manage dengue in impoverished and marginalized communities. We will study here the association with dengue and some poverty measure, like education and mean income level of people of different states in India.

Result 5: The correlation between total no. of Dengue cases in different states and per capita income level is 0.06269 which shows weak positive correlation.

Interpretation: Dengue virus initially affected the poor population as they use poor quality of water, basically stored water rather than piped water, but slowly it has affectedmiddle class and rich people due to widespread urbanization and change in climate conditions.

IV. CONCLUSIONS

It is well known that dengue, the mosquito-borne viral disease is one of the worst disease of not only in India but in the whole world. It is widely believed that dengue is caused by different reasons, like, variation in climate condition, variation in population density, income inequality and different others. The correlations analysis in this study showed that incidence of dengue has positive correlations with population density and per capita income while the correlation is negative with monsoon rainfall. The positive correlation with per capita income and negative one with rainfall is contrary to the expectations. However, any of these correlations is not found to be statistically significant. Therefore, data used in this study do not show any association between incidence of dengue and other variables considered.

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