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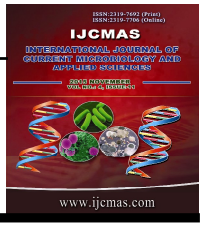

Review Article

Climatic Imbalance and their Effect on Prevalence of Dengue Fever in India

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A B S T R A C T

Dengue fever is becomes endemic and covers 100 countries with 2.5 billion peoples at risk. Its four serotypes *(DENV-1, DENV-2, DENV-3, DENV-4)* typically non-sever in initial infection but may be sever in later stage, due to organs impairments, plasma leakage and dengue hemorrhagic complications, excessive bleeding internally as well as externally. *DENV* is transmitted by female mosquito *Ae. aegypti* breed in fresh water stored in plastic containers, broken glass, small pitches etc. Climatic variation, like temperature, humidity, rains directly affects the breeding of mosquito and helps in transmission of the virus from one area to another. Transmission of dengue virus occurs, when mosquito sucks the blood of infected human and the same mosquito bite another healthy people transmit the virus in their blood, in between this period the virus survive in salivary gland and GI tract of mosquito. *Ae. aegpyti* mosquito directly proportional to environmental temperature, as temperature increases; it favors the growth of mosquito and increases transmission. Climatic as well as local conditions like global warming, dry habitat, low drinking water supply in cities, improper sanitary condition, defects in rain water harvesting system (RWHS), lack of awareness about dengue and their transmission makes it feasible becomes epidemic. Migration of infected people from one place to another is also an important reason for epidemic. There is need to improve not only our diagnostic facilities at field level, fogging by municipality, cleanness of surroundings, proper disposal of cans and plastic containers, improve water supply and their storage, repair of RWHS, prevent global warming effects but also awareness about dengue.

Introduction

The word "dengue" is derived from the Swahili phrase Ka-dinga pepo, meaning "cramp-like seizure (Nivedita Gupta *et al.*, 2012). Dengue fever (DF), break bone fever or Haddi Todh Bukhaar is a mosquito-borne *flaviviral* (an RNA virus of the family *Flaviviridae*) infection. It is the one of the fastest infectious disease in swelling tropical and sub-tropical areas. According to the World Health Organization (WHO), it is currently endemic to cover more than 100 countries with an estimated 2.5 billion population at risk. The annual number of infections is estimated at around 50 million

globally, with 500,000 severe cases accounting for the majority of the approximately 12,500 deaths (Yien Ling Hii, 2013).

Dengue virus was first isolated in Japan in 1943 by inoculation of infected serum in suckling mice (Nivedita Gupta *et al.,* 2012) and the first isolation of dengue in India occurred in Calcutta in 1945–46. India's first dengue fever epidemic was reported in 1963–64, when dengue gradually spread from the country's southern regions to its northern states and progressively to the whole country by 1968. The National Vector Borne Disease Control Program estimated that the average annual number of cases varies widely from the 20,474 to an annual 33 million apparent cases (Donald S. Shepard *et al.,* 2014).

Four serotypes of dengue virus have been discovered *(DENV-1, DENV-2, DENV-3, DENV-4).* While the first infection with one of the four dengue serotypes is typically non-severe or asymptomatic, individuals who are subsequently exposed in later years to one of the other serotypes are more likely to develop severe dengue (https://en.wikipedia.org/wiki/Dengue_fever). Symptoms include high fever, headache, joints pain, rashes, thrombocytopenia and leucopenia. In some cases it becomes fatal by severe organs impairments, plasma leakage and dengue hemorrhagic complications, bleeding nose or gum may be internal bleedings. Fatality rate is low but cannot be neglected.

Currently there is neither licensed vaccine against all serotype of dengue virus is not available and nor anti viral regimen is available for treatment. Patients infected with dengue self limiting and typically recovers within a week after symptomatic treatment with proper regimen. As per WHO a number of vaccines are under trials. The most advanced, a chimeric tetravalent vaccine based on the yellow fever 17d backbone is under III phase clinical trials. The development of a dengue vaccine is a high priority and WHO supports this effort through technical guidance and advice.

Causing vector

The main causal vector for the transmission of dengue fever is mosquito *Ae. aegypti* is now well documented. This vector has spread to rural areas and which were free from this disease (Singh *et al.,* 2011). Serotypes of *DENV* were passed on to humans through the bites of an infective female *Aedes* mosquito, which acquires when it on feeding of blood infected with Dengue Virus. Within the mosquito, the virus infects the mosquito mid-gut and subsequently spreads to the salivary glands over a period of 8–12 days. After this incubation period, the virus can be transmitted to humans during subsequent probing or feeding. Dengue outbreaks have also been attributed to *Ae. albopictus, Ae. polynesiensis* and several species of the *Ae. scutellaris* complex (http://www.who.int/denguecontrol/mosquito/en/). Each of these species has a particular ecology, behaviour and geographical distribution. In humans recovery from infection by one dengue virus provides lifelong immunity against that particular virus serotype. However, this immunity confers only partial and transient protection against subsequent infection by the other three serotypes of the virus. Evidence points to the fact that sequential infection increases the risk of developing severe dengue. The time interval between infections and the particular viral sequence of infections may also be of importance.

Flight range studies suggest that most female *Ae. aegypti* may spend their lifetime in or around the houses where they emerge

as adults and they usually fly an average of 400 metres. This means that people, rather than mosquitoes, rapidly move the virus within and between communities and places. The immature stages or larval stages of *Ae. aegypti* are found in water-filled habitats, mostly in artificial containers closely associated with human dwellings and often indoors (http://www.who.int/denguecontrol/mosquito/en/; Ghulam Muhammad Kundi *et al.,* 2014).

Dengue infection rates are higher outdoors and during daytime, when these mosquitoes (*Stegomyia*) bite most frequently (Cory W. Morin *et al.,* 2013). However, *Ae. aegypti* breed indoors and are capable of biting anyone throughout the day. The indoor habitat is less susceptible to climatic variations and increases the mosquitoes' longevity. Dengue outbreaks have also been attributed to *Ae. albopictus, Ae. polynesiensis* and several species of the *Ae. scutellaris* complex. Each of these species has a particular ecology, behaviour and geographical distribution (http://www.who.int/denguecontrol/mosquito/en/; Ghulam Muhammad Kundi *et al.,* 2014).

Ae. albopictus is primarily a forest species that has become adapted to rural, suburban and urban human environments. In recent decades, *Ae. albopictus* has spread from Asia to Africa, the Americas and Europe, notably aided by the international trade in used tyres in which eggs are deposited when they contain rainwater. The eggs can withstand very dry conditions (desiccation) and remain viable for many months in the absence of water and the European strain of *Ae. albopictus* can undergo a period of reduced development (diapause) during the winter months.

This review is biased on the previously research done by researchers published peer reviewed journals in context with dengue and their prevalence in context with environmental factor/climatic conditions since 2005 to current.

Pathogenesis

The epidemiological triangle of dengue includes host, pathogen and mosquito vectors. The transmission of *DENV* takes place (Suchithra Naish *et al.,* 2014), when *Ae. aegypti* mosquito sucks the blood of human infected with Dengue, virus gets enters in its GI Tract and replicates in its salivary gland to increase their number for further transmission. The incubation period of the pathogen in the mosquito is shorter if the ambient temperature is warmer (Sanjay Kumar and Rajesh Kumar, 2013).

Dengue is primarily transmitted by *Ae. aegypti*. *Aedes* mosquito has an ability to adapted local human habitation with oviposition and larval habitats in natural rock pools, tree holes and leaf axis, water tanks, blocked drains in rural and artificial, pot plants and food and beverage containers flower pots, water storage jars, cisterns, metal cans, discarded tires (Suchithra Naish *et al.,* 2014), and any other fresh water containers that people leave standing collections in the urban environments. Life cycle of *Ae. Aegypti* is directly influenced by ambient temperature and rainfall. As environmental temperature increases risk of dengue increases, so increase in transmission (Cory W. Morin *et al.,* 2013; Suchithra Naish *et al.,* 2014).

Climate changeability and dengue

Climate change refers to statistically significant discrepancy in either the signify state of the climate or in its quantifiable inconsistency, persisting for an extended

period (typically decades or longer). The worldwide mean surface temperature has increased by 0.74±0.18°C over the past 100 years, while the worldwide sea level has risen by 1.8 mm per year since 1961and the Arctic sea ice is retreating by 2.7±0.6% per decade. In addition, sea surface temperatures are warming, mountain glaciers are shrinking, and oceans are becoming more acidic, extreme weather events are increasing in frequency and intensity (Haliza Abdul Rahman, 2012).

Climate change is credited to natural processes and human activity altering atmospheric conditions. The Fourth Assessment Report released in 2007, by the Intergovernmental Panel on Climate Change (IPCC) stated that "there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities". Accelerating economic activity and fossil fuel combustion over the last century have precipitated an environmental impact of unprecedented proportions. Ecosystem decline, loss of biodiversity, stratospheric ozone depletion, and climate change are some of these environmental changes.

Climate change is likely to impact disproportionately upon the poorest countries and the poorest persons with in countries, exacerbating inequities in health status and access to adequate food, clean water and other resources (Haliza Abdul Rahman, 2012).

Warm temperature in night, favors the survival of *Ae. aegypti*, while cool at night is harmful to the mosquito activity. Global warming affects the spread of this disease because temperature favors the growth of vector (Sanjay Kumar and Rajesh Kumar, 2013).

Similarly an extreme hot temperatures may also increase the rate of mosquito mortality and thus decrease dengue risk and, rainfall can have non-linear contrasting effects on dengue risk Heavy rainfall may flush away eggs, larvae, and pupae from containers in the short term but residual water can create breeding habitats in the longer term (Yien Ling Hii, 2013; Suchithra Naish *et al.*, 2014).

It has been found that from few decades that human behavior becomes change for dry climate for saving water in water storage containers, which may become breeding sites for *Ae. aegypti*. So, climatic conditions may affect the virus, the vector and/or human behavior both directly and indirectly. However, empirical relationships have been demonstrated between climate variables, dengue and dengue vectors, casual relationships have not been strongly established.

As global climate change is predicted to accelerate over the next a few decades at least an increased frequency, intensity and duration of extreme climatic events are more likely, so affecting dengue transmission. This is a global public health priority. A better understanding of the relationship between climate and disease is an important step towards finding ways to mitigate the impact of disease on communities, for example, malaria (Suchithra Naish *et al.*, 2014).

It is considered that increase in global temperature may lead to expansion of area of involvement and number of cases of vector-borne diseases. This will increase the proportion of mosquitoes that become infectious at a given time leading to an exponential increase of dengue cases. In our study, temperature was found to be closely related with the rise of dengue infection (Md. Nazmul Karim *et al.*, 2012).

Researchers also have been reported that, most of the dengue epidemic cases occurred in the metropolitan cities across the country and in some rural areas in Punjab, Haryana, Karnataka, Tamil Nadu, Uttar Pradesh, Maharashtra and Rajasthan where the environmental factors like humidity, temperature, and rainfall are known determinants of dengue vector development. The climate variables, temperature was experienced with a range of 22 to 31°C, and relative humidity of 70 to 90 %, rain fall providing most suitable environment for fuelling the huge number of profusion of *Aedes* mosquito species breeding during the monsoon climate season of both southwest monsoon and the northeast monsoon from April to November and the vulnerability of epidemics reported during the months of mid July to mid November period of the year (Palaniyandi, 2014).

Effect of insecticide on *Ae. aegypti*

Researchers have been reported that, *Ae. aegypti* is resistant to DDT due to long term of their use but they are susceptible against malathion, permethrin, deltamethrin, lambda-cyhalothrin and cyfluthrin insecticide. It is needed to be use of such a insecticide whish are most effective against vector mosquito (Singh *et al.,* 2011). Peridomestic thermal fogging reduced the resting and biting for the 3 days after treatment, whereas indoor fogging suppressed adult populations for 5 days (Nivedita Gupta *et al.,* 2012).

Effect of flavonoid compound on *A. aegypti*

Chemicals derived from several plants have repellent against mosquito property. Flavonoid compounds derived from *Poncirus trifoliata* compounds have various activities against different life stages of *Ae. aegypti*. Larvicidal and ovicidal activities of benzene, hexane, ethyl acetate, methanol and chloroform leaf extract of *Eclipta alba* have shown potential for controlling *Ae. aegypti* mosquito (Nivedita Gupta *et al.,* 2012).

Rain water harvesting effect o Dengue prevalence

Due to change in climatic condition/global warming, human behaviour becomes changed ad think about storage of rain water for dry conditions, but defective Rainwater harvesting structures (RWHS) was also be served as better platform for dengue vector breeding and vector population profusion huge number of breeding habitats in the domestic and peripheral domestic areas. The defective rainwater harvesting structure accounted major proportion for breeding habitat of dengue vector mosquitoes (*Aedes* sp.) in the both urban and rural in India (Palaniyandi, 2014).

Other factors of breeding of dengue vector

The occurrence of dengue epidemic was determined by multiple factors, including climate, landscape, and the environmental dimensions. The regulation of irregular drinking water supply was supplied once in a week or 10 days, and hence, the village or some urban areas, people have practice of drinking water storage using big plastic container/ vessels and cement container. The replacement of bottled cool drinks by consuming the tender coconut was welcomed, but, a gigantic level of disposal of tender coconut shells found in the major cities of highways where the place of floating population was important for tourist attractions and, the vendors coffee bars, hotels and the petty shop business in the

highways, serve them cool drinks and tea, coffee milk etc in the disposal cups. There were a large number of domestic animals found in the affected villages of Andhra Pradesh, Tamil Nadu, Maharashtra, Pondicherry and Uttar Pradesh, as known hidden host of dengue (Palaniyandi, 2014).

Lack of awareness

Dengue is one of the major public health problems which can be controlled with active participation of the community. Need is to organize health education programmes about dengue disease to increase community knowledge and sensitize the community to participate in integrated vector control programmes (Nivedita Gupta *et al.,* 2012).

Common people are not much aware about the vector mosquitoes, disease transmissions, vector breeding habitats and the source reduction of vector mosquitoes breeding habitats. Reviews reported that moderate rain during the summer, a week interval of drinking water supply, absence / negligence of block wise periodical entomological survey of dengue vectors for source reduction of vector breeding and lack of awareness of the common people are the causes that are collective responsible for creating conducing environment for fuelling for propagation of *DENV*.

Future research:

The dengue infection is a huge problem in country that covers number of peoples. Limited medical and diagnostic facilities at rural areas, inadequate mosquito controls by local municipality and all the ground conditions including climatic weathers that favour expansion of the vector. This country needs a large number of virus laboratories that may provide quick and reliable diagnosis for not only DENV but also for other viral epidemics. In this field of viral lab setup, great efforts have done by Indian Council of Medical Research (ICMR) in co-ordination with govt. of India, to be made to develop improved, proactive, laboratory-based for viral diagnosis at early stage, so that transmission can be controlled effectively. There is need to have a strong epidemiology/ pathology/experimental pathology backup. Our efforts are limited only to the stage of crisis management. We need dedicated teams to solve the problems and minimize the human suffering from Dengue. Vaccine for dengue infection is also a challenged and need more efforts and successful trials.

There is also a need for improve rain water harvesting system, storage of drinking water, propel disposal of plastic cans, containers, bottles and any other objects for storage of water. Successful future management of dengue requires an understanding of the dynamics of the virus, host, vector, and environmental factors especially in the context of a changing climate.

In conclusion, climatic factors influence the emergence and reemergence of infectious diseases, in addition to multiple human, biological, and ecological determinants. Climatologists have identified upward trends in global temperatures and now estimate an unprecedented rise of 2.0°C by the year 2100. Addition, understanding the linkages between climatological and ecological change as determinants of disease emergence and redistribution will ultimately help optimize preventive strategies.

The review has an aim to decrease the prevalence of dengue by awareness about climatic conditions and their role in transmission, and the motivation behind this analysis is to start a wider discussion for a

more robust assessment of climate impacts and their valuation across sectors in India. As all of us known breeding places of mosquito, their favourable optimum temperature for growth, it's our duty to don't create such environment which favours the larval growth. Rain water harvesting system should be in proper that, they properly work and no water storage in open spaces. People cover him during day time, use chemically treated mosquito net, kept surroundings clean, Hygienic. It is also necessary that local municipal corporation must be aware and take serious actions in those places /areas, where peoples infected with dengue fever, because those peoples are the source of infections. Hence in the agriculture sector, the study has looked only at output losses of three major food crops- rice, maize and wheat. However climate change will impact all categories of crops ranging from oilseeds to fruits and vegetables. Health impacts of climate change include mortality at old age due to heat waves, higher incidence of malnutrition, etc. while we have focused on deaths related to three important diseases Diarrhea, Malaria, and Dengue.

Reference

Cory W. Morin, Andrew C. Comrie, Kacey Ernst, 2013. Climate and dengue transmission: evidence and implications. *Environ. Health Perspect.*, 121(11–12).

Donald S. Shepard, Yara A. Halasa, Brij Kishore Tyagi, Vivek Adhish, S., Deoki Nandan, K.S., Karthiga, Vidya Chellaswamy, Mukul Gaba, Narendra K. Arora, 2014. Economic and disease burden of dengue illness in India. doi:10.4269/ajtmh.14-0002.

Ghulam Muhammad Kundi *et al.* 2014. An analysis of the ttitude of people towards prevention and control of dengue in District Bhakkar Punjab Pakistan. *J. Environ. Earth Sci.*, 4(9). www.iiste.org.

Haliza Abdul Rahman, 2012. Climate change and dengue fever diseases: any association?, School of Health Sciences, Universiti Sains Malaysia. *Int. Sci. J. Environ. Sci.*, Vol. 2.

http://www.who.int/denguecontrol/mosquito /en/

https://en.wikipedia.org/wiki/Dengue_fever.

Md. Nazmul Karim, Saif Ullah Munshi, Nazneen Anwar, Md. Shah Alam, 2012. Climatic factors influencing dengue cases in Dhaka city: a model for dengue prediction. *Indian J. Med. Res.*, Pp. 32–39.

Nivedita Gupta, Sakshi Srivastava, Amita Jain, Umesh C. Chaturvedi, 2012. Dengue in India. *Indian J. Med. Res.*, 136: 373–390.

Palaniyandi, M. 2014. The environmental aspects of dengue and chikungunya outbreaks in India: GIS for epidemic control. *IJMR*, 1(2): 35–40.

Sanjay Kumar, Rajesh Kumar, 2013. Environment change: broaden of diseases. *Int. J. Curr. Microbiol. App. Sci.*, 2(5): 60–66.

Singh, R.K., Dhiman, R.C., Mittal, P.K., Dua, V.K. 2011. Susceptibility status of dengue vectors against various insecticides in Koderma (Jharkhand), India. *J. Vector Borne Dis.*, 48: 116–118

Suchithra Naish, Pat Dale, John S Mackenzie, John McBride, Kerrie Mengersen, Shilu Tong, 2014. Climate change and dengue: a critical and systematic review of quantitative modelling approaches, BMC Infect. Dis., 14: 167 Page 2 of 14. http://www.biomedcentral.com/ 1471-2334/14/167

Yien Ling Hii, 2013. Climate and dengue fever: Early warning based on temperature and rainfall: Umeå.